University of Alberta

Does Instructional Medium Affect Verbal Classroom Behaviours?

by

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Abstract

This study examined the teaching behaviours of a teacher who taught the same high school math course in a videoconferencing classroom and a traditional classroom. A quantitative analysis was done to determine any statistically significant dependencies in specific teaching behaviours, general student behaviours and silences between the two environments. Quantitative data were gathered by recording the classroom behaviours at 5 second intervals based on a subscripted version of the Flanders Interaction Analysis System (Flanders, 1970). A qualitative analysis was also performed to reveal potential explanations for any significant dependencies, as well as to determine whether or not the teacher was able to predict differences in her teaching behaviours between the two instructional media. Qualitative data were gathered through a phone interview, daily debriefing sessions with the teacher and a reflective observation journal.

A statistical analysis using a chi-square test for independence found that there were significant dependencies in 11 of the 21 categories that were examined. The teacher was also able to accurately predict 6 of the 8 significant dependencies that related to her verbal teaching behaviours.

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Chapter One - Overview

Background to the Project

The Rural Advanced Community of Learners (RACOL) project is an initiative to bring synchronous and asynchronous instruction to classrooms in a rural school division in northern Alberta. The Fort Vermilion School Division (FVSD) is located in the Northwest corner of the province of Alberta, Canada and is located approximately 800 kilometres Northwest of Edmonton, Alberta's capital city. The district covers over 87 000 square kilometres and encompasses approximately 12% of Alberta's landmass (Fort Vermilion School Division, 2003).

There are five secondary schools in the division. Each of these schools is geographically separated, sometimes by more than 100 km. Many of the smaller schools have very few students enrolled in secondary courses, which often means that administrators cannot justify offering a course to such a small number of students. Another common problem is that the schools simply do not have enough qualified teachers to be able to offer all of the courses that would normally be available to students in Alberta schools. These schools have made attempts to offer courses to their students through both correspondence courses and audiographic courses, but both initiatives were met with limited success. Though the audiographic courses were seen as a step forward from traditional correspondence courses, both teachers and students who had worked with the technology expressed a great deal of frustration with the limitations of the medium.

These challenges led to a partnership between the Fort Vermilion School Division and the University of Alberta. These two institutions, along with a number of other partners, began to explore possibilities for offering more interactive courses to multiple locations within the division by using broadband networks and other digital technologies (Montgomerie, King & Dropko, 2003). With the knowledge that the Alberta SuperNet was about to be installed in the area, the notion of real-time collaborative video learning became a feasible prospect for the district.

The Alberta SuperNet is a high-speed broadband network that was created to connect public facilities in Alberta communities. It links government offices, schools, health-care facilities and libraries in over 422 communities (Government of Alberta, 2002a). In the fall of 1998 a publicly appointed board of Albertans called the Alberta Science and Research Authority presented the idea of the Alberta SuperNet in a document they tabled called "Information and Communications Technology: A Strategy for Alberta" (Government of Alberta, 2002b). This document was intended to outline the necessary tools and infrastructure needed to maintain information and communication technologies in the province. The concept of the SuperNet emerged as a proposed means to end disparity between communities who did not have equal access to high speed networks and the Internet because of their geographic location.

With the knowledge that a high speed network was being created by the Government of Alberta to link the Fort Vermilion School Division with the rest of the province, the idea of RACOL and multipoint videoconferencing from school to school quickly moved into the development stages. The project was to use the broadband technologies which were supported by the Alberta SuperNet to deliver instruction synchronously via videoconference as well as asynchronously via stored video streams of each lesson that had been presented over the videoconferencing system. Videoconferencing instruction would be able to be delivered from a teacher at one school to students in up to four other schools within the district. The video streams of each lesson were then recorded and archived on a streaming server, accessible through a web interface so that students could access any lesson from any course in which they were enrolled. They could access these archived lessons at any time from either home or school.

RACOL was launched at the beginning of the 2003-2004 school year with video classrooms in each of the five secondary schools in the Fort Vermilion School Division. Five teachers, all in different schools (and one in a different school division), were recruited to teach classes over the system. Courses offered during the school year included Math 10, Math 20, Science 10, Science 20, Physics 20, Physics 30, Career and Life Management 20, Aboriginal Studies 10 and French 10.

Teachers were able to teach these courses to multiple locations through special classrooms called Virtual Presence Learning Environments (VPLEs) that were designed specifically for the RACOL project. The VPLEs were developed so that the teachers using them would have to do a minimum number of things differently than they would in a normal classroom, and be able to teach with as much ease as they would in a traditional classroom setting.

Each VPLE was equipped with digital tools intended to provide the same teaching opportunities that a teacher would have in a traditional classroom. These tools included a high quality videoconferencing system, a SMART Board™ 3000i interactive whiteboard, an audioconferencing system (to act as a backup should the video system go down), a visualizer, VCR, DVD/CD player, three computers with high-speed internet access as well as PolyCom ViaVideo desktop cameras for small group videoconferencing and a touch sensitive teacher control panel (see Figure 1).

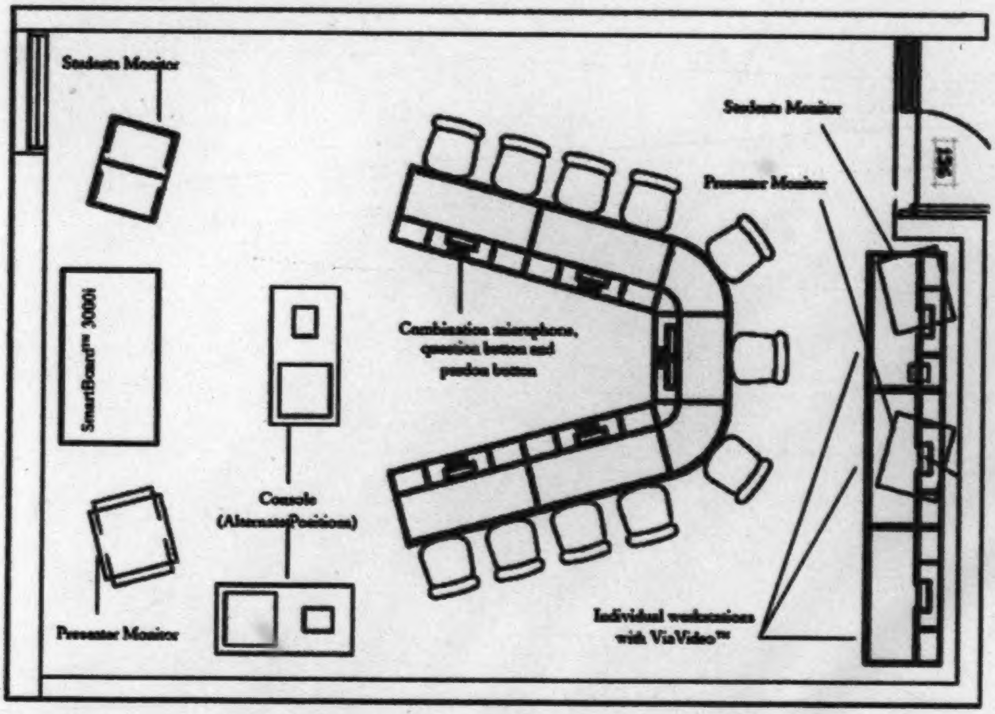

Students Monitor
SmartBoard™ 3000i
Presenter Monitor
Console
(AlternatePositions)
Combination microphone,
question button and
pardon button
Students Monitor
Presenter Monitor
Individual workstations
with ViaVideo™

Figure 1. Schematic diagram of the VPLE. Schematic courtesy of Dr. T. Craig Montgomerie.

The rooms were also equipped with a number of other electronic devices necessary for the videoconferencing system to function, such as television monitors, microphones and speakers, as well as consoles so that both students and teachers could hook up laptop computers. Using this set of tools, each VPLE could send or receive a lesson presentation from any of the other VPLE classrooms in the division.

Student stations were built in a U-shape facing the interactive whiteboard and front television monitors. Each pair of student stations was equipped with two buttons. The red question button allowed students to ask questions and a yellow confusion button allowed students to indicate to the teacher that they did not understand the material that was being presented. When the question buttons were pushed, the teacher had the choice of accepting the question immediately by touching the teacher control panel, or delaying the question until later in the lesson. When the teacher did accept a question, the video cameras automatically zoomed in on the student at his or her individual location so that the teacher and all of the other students could see the student close-up while they were asking their question. When the yellow confusion buttons were pushed, an accumulator on the teacher's console was incremented so that the teacher could see a tally of how many of those buttons had been activated at any given time. The RACOL teachers have found innovative ways to integrate these buttons into their teaching, including using the confusion buttons for polls and attendance, and using the question buttons to play Jeopardy-like trivia games.

When the system was in full operation, each of the classrooms that were connected could see all of the other classrooms on one monitor, as well as the teacher or presenter on a second monitor. The teacher could set a different location as the main presenter so that students or guest speakers could do presentations and be seen full screen on the presenter monitor (Montgomerie, King & Dropko, 2003). The content that was displayed on the interactive whiteboard was displayed in real-time and any other input device that the teacher wished to use to show content, such as the DVD player, could easily be selected as the main input and displayed to all of the other locations on the presenter monitor. Teachers could also use the classroom cameras to zoom in or zoom out on any student at any location so that they could hear questions or supervise students to ensure classroom behaviour was appropriate.

There was a great deal of technology in these VPLE classrooms. This was partly because videoconferencing at this scale requires a great deal of equipment, but also because every effort was made to create as much of a "natural" teaching environment as possible. The rooms were designed so that teachers could do almost anything they would be able to do in a traditional classroom short of touching a student or handing them a piece of paper. Moreover, the rooms were created so that when all the equipment was working ideally, teachers would need to have a minimum amount of interaction with the technology. For example, a scheduling system was created for the videoconferencing system, which automatically connected all of the correct classroom locations when it was time for a specific class to begin. Literally all the teachers had to do was step into the room and start teaching. If the teachers did decide to use the other technology components in the room, like the visualizer or VCR, they could control the input using a touch-pad interface that allowed them to touch a picture to choose what they wanted students to see. The rooms were designed this way so that the technology problems that have traditionally plagued videoconferencing teaching would not be a hindrance to the teachers in the RACOL project.

With this much technology in a single classroom, professional development and training became a core element of the RACOL project. There were three main methods of support for the teachers participating in the RACOL project. The first was a series of professional development sessions that were delivered several times throughout the 2003-2004 school year (Fiege, Peacock & Geelan, 2003). The second was the RACOL web site, which contained extensive lists of teacher resources, links, documentation as well as recaps of past events and discussions. Every effort was made to provide the teachers with both theoretical and practical resources to draw on as their needs were made clear through spending more and more time teaching in the VPLEs.

The third method of support for this program was a series of streaming video vignettes. These vignettes were created to impart the best practices of the teachers using the system during the initial year of the project to teachers who would use the system in subsequent years (Peacock, 2004). The video vignettes were intended to reflect a classification of various types of best practices based on both the experiences of the RACOL teachers and on a review of the literature involving similar video-based initiatives in other high schools across the world.

Research Problem

While compiling the literature on teaching best practices using large-scale videoconferencing technology for instruction in secondary schools, it became obvious that the literature was very focused on two specific elements:

1. The effectiveness of videoconferencing instruction based on student achievement and/or attitudes (Bruning, Landis, Hoffman & Grosskopf, 1997; Fillion, Limayem & Bouchard, 1999; Cavanaugh, 2001; Knipe & Lee, 2002; Larson & Bruning, 1997; Machtmes & Asher, 2000; Martin & Rainey, 1997; Moore & Thompson, 1990; Russell, 1999).
2. Teaching best practices that were focused on planning and designing to promote high levels of interactivity, specifically relating to constructivist learning models (Berge & Mrozowski, 2001; Kelsey, 2000; Ritchie, 1993; Rost, 2000).

Very few of the studies actually focused on teaching rather than learning and moreover, when they did focus on teaching, the focus was not on the actual teaching process, but more on what the teacher was doing to plan for videoconferencing delivery that would promote student interaction, usually within a constructivist learning model.

There was another large collection of literature that consisted purely of recommendations for effective teaching using videoconferencing technology

(Cyrs, 2003; Greenberg, 1998; Mielke, 1999; Reed & Woodruff, 1995). These documents were largely non-peer-reviewed articles that consisted mainly of lists of "what to do" and "what not to do" when teaching using videoconferencing technology. While the expert opinion of the teachers behind these documents was likely valid, there was often little to no examination of why these methods worked or any empirical data to back up the claims made by the authors. Overall, there was very little quantifiable research on what teachers were actually doing when teaching in their videoconferencing classrooms.

Purpose of the Study

Given the lack of available research that focuses on teachers' videoconferencing practices, I decided to conduct a case study analysis that would examine the actual teaching practices of a teacher who taught the exact same class in both a videoconferencing environment (i.e., the VPLE) and a traditional classroom environment. More specifically, this study examined whether or not teaching through a videoconferencing medium is more conducive to certain types of verbal behaviours, where time is spent in both environments, and whether there are any statistically significant dependencies between the two. Furthermore, a qualitative analysis was also conducted to explore what potential explanations there might be, aside from the delivery medium itself, for any differences in teaching behaviours, as well as to examine any other factors that the teacher felt might be influencing her behaviours. The qualitative analysis also examined whether or not the teacher was able to predict any possible differences in her own teaching behaviours between the two environments. The specific research problems that were explored are outlined in detail in Chapter Three.

Delimitations of the Study

The most important delimitation of this study was the choice to examine only one of the teachers involved in the RACOL project. Only one of the teachers participating in the project was teaching the same course in the two different environments and was therefore asked to be part of this study by default. Even though there were other teachers who taught courses in both environments, none of them taught the exact same course, and including them would have resulted in confounding due to the different subject matter being taught. To keep confounding to a minimum, only the teacher who was teaching the exact same course in the two environments was examined as part of this study.

The second major delimitation of this study was the choice to examine only the verbal behaviours of the teacher. It would have been preferable to measure a larger variety of variables, such as the specific types of learning activities she employed, or her physical behaviours within the classroom. However examining these elements was problematic for a number of reasons. As a single observer, it would have been very difficult for me to examine and accurately record the teacher's verbal and physical behaviours because I would have had to watch the teacher and the verbal behaviour coding sheet at the same time. It would have simply been too much for me to observe and record two types of behaviours at a time and the reliability and validity of the data would have been compromised because of it. The choice was made to observe the verbal data because I felt it was least likely to be practically influenced by the two different environments. For example, if I had chosen to examine physical behaviours, the teacher would have been naturally restricted by the instructional media. She would not have been able to physically interact with her students in remote locations, or look over their shoulders and would have even had a difficult time looking them in the eye. It is reasonable to assume that physical behaviours would have to change due to the instructional medium. However, it is not as easily assumed that verbal behaviours would be influenced in the same way. There aren't the same kinds of tangible barriers to verbal behaviours in the two environments that exist for physical behaviours. Nothing would prevent the teacher from saying the exact same things word for word in both of the environments, however, there would be tangible limits to the teacher's physical behaviours in the two different environments.

Finally, the third delimitation was the choice to examine the teacher for only three days. Due to budgetary reasons, I was only able to be in the school division for one week. During that week, the teacher was available four of the five days. The Thursday of that week she attended a district inservice and had a substitute teacher. Therefore, Monday of that week was set aside for the pilot, while the actual study was conducted on Tuesday, Wednesday and Friday.

Limitations of the Study

There were a number of major limitations to this study. The first one was the question of the generalizabilty of a single case study and whether it was useful to conduct the study on one individual. It will be difficult to generalize any findings from this study to a larger population. Unfortunately, there was only one teacher who met the criteria of teaching the same course in the two different environments, therefore performing this research study with more than one teacher simply wasn't possible. However, even if the study does not result in generalizable results, it will hopefully foster reflection and an awareness of teaching methods in those teachers who do teach using multiple media. It may also serve as a justification for further study that goes beyond a simple descriptive case study analysis.

The second limitation in the study was the presence of a local group in the videoconferencing classroom. Even though the teacher was teaching a distance education course via videoconferencing, she also had local students at the location she was teaching from. It is possible that this influenced the amount and/ or nature of the teacher's behaviours in the classroom, but unfortunately, there was no way to disentangle the influence of the local group in this study. From a strictly research perspective, the validity of the study would have been stronger if the teacher had have been teaching in a "pure" distance educational setting where all of her students were separated from her and had to interact through the technology medium. However, from a practical perspective this was less of an issue, as having a "pure" distance educational setting is less common, while having a local group is common practice within videoconferencing courses.

The third limitation of this study was the fact that my presence in the classroom may have impacted student and/or teacher behaviour. Introducing a new individual into a classroom has the potential to change how students or teachers behave. However, some data emerged from the qualitative analysis that indicated that this was likely not the case. These findings are discussed in more detail in Chapter Four.

The final limitation of this study, and perhaps the most significant, was that there were different students in the two classes. This could account for any differences in teaching behaviours, rather than it being because of the instructional medium. If this study were at a post-secondary institution where class sizes were large and interpersonal relationships between professor and student were less pronounced, this might not have been an issue. However, because each of the classes were quite small and "intimate," the teacher was quite obviously able to build individual relationships with her students. Unfortunately, it is impossible to perform a media comparison study without some kind of confounding. Either the subject matter must be different, or the students must be different. A teacher delivering the same course to the same students likely wouldn't be able to teach naturally knowing that the students had already heard the information before.

Clarification of Terms

For the purposes of this thesis, a clarification needs to be made of a key term. The instrument used in this study was a modified version of the Flanders Interaction Analysis System (FIAS) (Flanders, 1970). Interaction as it relates to education traditionally refers to a set of dependent actions between an individual and another individual, a group of other individuals, their environment, or the learning content.

In this study, I examine interactions in a more compartmentalized way. Each of the teacher and students' verbal actions or inactions (i.e., silences) were observed and coded according to the FIAS, but they were not examined as pairs as in a traditional interaction analysis. As such, I refer to these individual actions as verbal behaviours. They are often still part of an interactive process, however, I am only analyzing them as single behaviours within the context of this study.

Structure of the Thesis

Chapter One of this thesis provides some background and context for the research study, and introduces the main research problem. Chapter Two consists of a literature review that examines distance education, videoconferencing, interaction, and some possible influences of technology on teachers and their interaction patterns. The review also examines some theoretical frameworks in distance education, and constructs of presence that have emerged from those theories. There is also a brief examination of the media debate, some of the criticisms that have emerged from research on videoconferencing and media studies and some of the possible responses to those criticisms. Chapter Three outlines the research methodology of this study, including the pilot test and modifications made to the instrument. Chapter Four outlines the results of the quantitative component of the study, as well as the qualitative results from discussions and observations, and the teacher's predictions regarding her own behaviours. Finally, Chapter Five discusses each of the research questions in detail in light of both the qualitative and quantitative findings, and discusses other findings that emerged from the qualitative analysis. This chapter also presents a model of interaction that was created based on the findings of this study, some of the potential implications of the findings and recommendations for future research.

Summary

The RACOL project was an initiative to bring broadband synchronous and asynchronous delivery of teaching to students in a rural school district in Northern Alberta. The project employed a number of technological tools to create Virtual Presence Learning Environments (VPLEs), immersive technology classrooms that were built to function as naturally as traditional classrooms.

Teachers who were asked to teach in the project were provided with extensive professional development in order to be able to use the technology effectively. They were also provided with a number of other useful tools including a web site and a series of best practice vignettes. During the research phase of the best practice vignettes it became apparent that research in the area of video conferencing was largely unbalanced. There were many studies examining the effectiveness of videoconferencing as it related to student achievement and attitudes, but very little research on what was actually going on in videoconferencing classrooms. The studies that did examine videoconferencing from a teacher perspective were largely collections of what teachers felt were best practices in terms of general planning and planning for interaction, but did not extend into examining what teacher did to implement those practices.

The purpose of this research study is to examine the verbal behaviours of a RACOL teacher who was teaching the exact same class using two different instructional media. A quantitative component of the study examines the actual differences between her verbal teaching behaviours in both environments and a qualitative component examines possible explanations for any differences, and whether or not the teacher was able to accurately predict them.

There were a number of delimitations in this study. The first was the choice to examine only one teacher because only one met the criteria of teaching the same course in the two different teaching environments. The second was to only examine the verbal behaviours of the teacher and not physical or other nonverbal ones. The third delimitation was the choice to examine the teacher over a period of three days.

There were also a number of limitations to the study, including the drawback that a one-shot descriptive case study is not generalizable, the presence of a local group may have influenced the results in the videoconferencing classroom, and the fact that as an observer, I may have had an effect on the behaviours of the teacher and students. There was likely confounding in the study because there were different students in each of the classrooms whose personalities and relationships with the teacher may have influenced their interactions and the behaviours of the teacher.

Chapter Two - Literature Review

Overview of the Chapter

The following literature review examines a broad perspective of the field of distance education, as well as the specific medium of videoconferencing and some of its benefits and drawbacks. It also examines the current state of research in videoconferencing, with a specific focus on teaching activities, the impact of technology on students and teachers and the nature of student-teacher interaction in videoconferencing environments. This is followed by a discussion of how this research fits into current theoretical frameworks of distance education and some important constructs that have emerged from those theories. Finally, there is an examination of the criticisms of videoconferencing research, including a brief examination of the media debate, as well as some of the possible responses to those criticisms that have emerged in recent years.

Distance Education

Most definitions of distance education have generalized the field to any type of formal learning that happens when the teacher and learner are separated geographically. However, a more specific definition of distance education that was put forth by Kearsley and Moore (1996) has become frequently cited in recent years. This definition described distance education as:

> "Planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements" (p. 2).

In more simple terms, distance education is "any formal approach to learning in which the majority of the instruction occurs while the educator and learner are at a distance from each other" (Grimes, 1993, p. 7). Some theorists have emphasized the idea that distance learning is more than just a separation of learners, but an entirely new pedagogical concept (Kwielford & Goodfriend, 1999; Moore, 1993). They have emphasized that "distance learning is both a location and a concept that allows teachers and students to communicate despite a separation of time and space" (Kwielford and Goodfriend, p. 16).

Regardless of the nature of distance education, it has become a distinct field of educational study. More and more institutions are delivering programs via distance education. Keegan (1996) has pointed out that "distance education is a valued component of many education systems and has proved its worth in areas where traditional schools, colleges and universities have difficulties in meeting demand" (p. 4).

One of the reasons distance education is becoming more prevalent in our society is because of our increased ability to communicate. If distance education is the art and science of allowing students and teacher to communicate over distance with the purpose of learning, the newer and faster communication technologies that are emerging are often facilitating that distance education process.

For many years, distance education was thought of as paper and pencil correspondence courses and other asynchronous methods of delivery (Bates, 1995; Garrison, 1993; Kearsley & Moore, 1996; Keegan, 1993; Keegan, 1996).

However, with the evolution of synchronous communication technologies, definitions of distance education are changing and evolving. Garrison (1993) points out that "with the emergence of a variety of affordable communications technologies, those in conventional education find fewer philosophical and practical concerns with delivering education at a distance. The debate around distance education has often been reduced to issues of access and quality" (p. 9). Synchronous technologies have evolved to the point where access and quality are not the issues they used to be, and as a result, the definitions and methods of distance education are changing as well.

The emergence of synchronous technologies have led some theorists to create entire new terms and even paradigms within distance education (Garrison, 1993; Keegan, 1996). Keegan (1996) has differentiated between distance education (asynchronous education) and virtual education (synchronous education). According to his definitions, the terms differ on 5 points:

- Time synchronous technology - virtual education is synchronous, while distance education is not.
- Access - virtual education access is often limited in terms of time and location of access, while distance education is not.
- Economics - virtual education tends to be more costly.
- Didactics - the skills required in a virtual education course are similar to a traditional classroom, while distance education is more self-directed.
- Market - virtual education has yet to demonstrate it has a market worldwide as distance education has.

Unfortunately, because synchronous learning technologies are relatively new and in many cases, slow to be adopted, the research that has been conducted into many of the specific areas of synchronous learning - videoconferencing in particular - has been largely unbalanced. However, according to a recent critical review of the use of videoconferencing in US distance education by Motamedi (2001), there are two modes of distance education that are emerging this decade as the most prominent: videoconferencing and web-based learning.

Videoconferencing

Videoconferencing is a method of distance education that has become more common as bandwidth has increased and technology has advanced. Often referred to as interactive television (ITV), two-way video/television or compressed video technology, it can generally be defined as "live, two-way audio and full-motion video communication" (Heath & Holznagel, 2002, p. 2). Yocom and Whitson (1995) defined it as "an interactive technology that enables live, two-way audio and video signals to be transmitted simultaneously among sites with specialized equipment" (p. 266). One of the key aspects of videoconferencing is its ability to connect more than two locations. Laurillard (1993) defined it as a "one-to-many medium, making it a sensible way to provide access for many sites to a remote academic expert" (p. 166). This is often true; however the benefit of videoconferencing also lies in its ability to connect learners to each other, as well as the teacher. A recent literature review of videoconferencing in K-12 schools examined the body of videoconferencing literature as a whole. This review found that the most common uses of videoconferencing in the existing research are:

- university courses,
- high school equivalency courses,
- K-12 enrichment projects and courses,
- staff development meetings, and
- community contact (Heath and Holznagel, 2002).

Benefits of Videoconferencing

Like any instructional medium, videoconferencing has its own set of strengths and weaknesses. Many practitioners have created lists of both benefits and drawbacks to videoconferencing that they have experienced in their own videoconferencing projects. In a collection of best practice guidelines based on their own experiences teaching with videoconferencing, Reed and Woodruff (1995) outlined four main benefits of videoconferencing technologies in teaching. First, they allow teachers to make a visual connection with students. Second, they allow more potential for interaction and let teachers use more interactive teaching techniques. Third, they often allow a connection with the "outside world" and consequently, outside resources and experts. And finally, videoconferencing technologies allow for the integration of a very diverse set of media, such as document cameras, that allow teachers to share resources with students. Sullivan, Jolly, Foster and Tompkins (1994) have written extensively on the use of videoconferencing in K-12 rural schools. From their examination of six, two-way full-motion video and audio initiatives in New Mexico, Oklahoma and Texas, they outlined a number of different benefits they have seen coming from the videoconferencing classrooms in those schools:

- it allows continuous interaction,
- it allows a high degree of relevance for individual learners by clustering students based on their educational needs,
- it is often a stimulating learning environment for students,
- it offers the flexibility of connecting to other schools and institutions,
- it has become more affordable,
- it allows cooperative arrangements and partnerships with businesses, schools and institutions,
- it often allows for simultaneous access to outside information using other technologies, and
- videoconferencing classrooms have the potential to become a school/community production center.

A 13 week study of the effectiveness of teaching multiple undergraduate class sections at once at the University of Technology Sydney (Freeman, 1998) found that videoconferencing as an instructional method could reduce duplication of teaching by allowing multiple groups to be connected and could also give students more equitable access to courses, information and experts.

Cochrane (1996) pointed out that many school districts and institutions find larger scale benefits for implementing videoconferencing programs. He stated that "the motives for using videoconferencing are varied and include providing access to learners in remote areas, ensuring that students are exposed to a technology which is increasingly used in professional practice, and easing course delivery problems with separate institutions merge" (p. 318).

Drawbacks of Videoconferencing

In a recent literature review of the use of videoconferencing in American distance education, Motamedi (2001) stated that although there are a number of obvious benefits to using videoconferencing as an instructional medium, there are also a number of serious drawbacks that should be considered before it is chosen. He pointed out that even though hardware and bandwidth costs have improved over time, videoconferencing infrastructure is still a serious financial investment for most schools and post-secondary institutions. Those equipment, transmission and personnel costs must be justified by the benefits the technology brings. Furthermore, Motamedi cautioned that the skilled expertise required to design and implement videoconferencing technologies properly can be both rare and costly. Once the technology is in place, another potential drawback is that it is often hard for teachers and learners to master using it. Not only is there often a lack of training on how to use the technology, but there is often inadequate teacher training for teaching using such a specialized medium. The result is often poorly constructed courses that do not take advantage of the benefits of the medium. Another drawback is the limited number of students that videoconferencing technologies can accommodate. Motamedi warned that although it is tempting to lump large numbers of students in videoconferencing classrooms as you would put viewers in a movie theatre, for the medium to be effective, learners must be kept in small groups so that the full value of the interactive aspect of the medium can be taken advantage of by both teacher and learner. Finally, Motamedi warned that a common problem found in the literature is that videoconferencing teachers are often not trained to use videoconferencing technologies in ways that are pedagogically sound. His review found that too much teacher time on screen or inadequate class preparation often led to unmotivating classroom experiences (e.g., the teacher as talking head) which often set students into a more passive learning mode. He surmized that for videoconferencing to be effective, much effort needed to be placed on sound pedagogy and good lesson planning.

Many studies have also pointed out that technology problems are often a significant drawback of videoconferencing initiatives (McIsaac & Gunawardena, 1996; Oliver & Reeves, 1996; Reed & Woodruff, 1995; Ritchie & Newby, 1998; Roblyer, Edwards & Havriluk, 1997). One study of student concerns in the implementation of videoconferencing in seven different courses at their post-secondary institution found that students listed technical difficulties as their primary concern in taking courses using videoconferencing (Armstrong-Stassen, Lanstrom & Lumplin, 1998). Roblyer, Edwards & Havriluk (1997) have also stated that network problems often cause significant disruptions in student learning.

Generally, a number of studies have found that videoconferencing is perceived to be second best when compared to the traditional face-to-face classroom (Dallat, Fraser, Livingston & Robinson, 1992; Fillion, Limayem & Bouchard, 1999; Freeman, 1998). Dallat et al. point out that this is especially the case when high interaction is essential for the success of the class. A study by Armstrong-Stassen, Lanstrom & Limplin (1998) also found that students in the seven videoconferencing courses they examined at their post-secondary institution reported significantly less positive attitudes towards videoconferencing after having taken a videoconferencing course.

Research Trends in K-12 Videoconferencing

Two recent summaries of the research in videoconferencing education have found that there have been a very limited number of research studies done on videoconferencing at the K-12 level. Most studies have focused on university courses and professional use, with a very limited number focusing on the high school grades (Heath & Holznagel, 2002; Moore, 2002). In a point that was particularly relevant to this study of secondary Math classes, Heath & Holznagel also questioned "if most of the existing research has been conducted with audiences of college students and other adults, its validity for high school age or younger students can be questioned" (p. 3). However, they did indicate that it might be reasonable to generalize findings from post-secondary studies to high school students because the lecture format of many high school classes so closely resembles the lecture format of many post-secondary classes. Therefore, since RACOL is a videoconferencing project at the secondary level, some research from post-secondary studies are considered in this literature review, especially when there has been no research done in that particular area at the K-12 level. Every effort was made to select research studies that were applicable within the context of the RACOL project and the students in the Fort Vermilion School Division.

Of the studies that have been done comparing videoconferencing to traditional classrooms, a large majority have focused on the effectiveness of videoconferencing in terms of student attitudes, satisfaction and achievement (Machtmes & Asner, 2000; Moore 2002). However, there is a slowly growing number of studies that have explored learner characteristics, classroom interaction and effective course and lesson design (Machtmes & Asner, 2000; Moore 2002). With the exception of the studies on effective course and lesson design, videoconferencing research has been predominantly learner-centric and has frequently ignored the teaching process and the teacher's role in student-teacher interaction via videoconferencing.

Classroom Interaction in Videoconferencing Research

It is generally thought that there are three main types of interaction in videoconferencing classrooms:

- learner - content,
- learner - learner, and
- learner - instructor (Kelsey, 2000; Moore, 1993).

Until recently, the second type of interaction was almost unheard of in distance education contexts. According to Moore (1993), "the most important evolution in distance education has been the development of highly interactive telecommunications media.... Above all, the teleconferencing media allow a new form of dialogue that can be called inter-learner dialogue" (p. 32). This inter-learner dialogue has meant that distance education has begun to have the capacity to look more and more like traditional education by allowing students to communicate with each other.

There have been a few studies conducted on interaction in the classroom, but these studies have focused on the frequency of student-teacher interactions rather than the types of interaction (Freeman, 1998; Kelsey, 2000; Murphy, 1999; Ritchie, 1993; Rost, 2000). These studies have shown that there was either the same amount (Murphy, 1999; Rost, 2000) or less (Freeman, 1998; Kelsey, 2000; Ritchie, 1993) interaction in video classrooms compared to traditional classroom settings.

One study by Oliver and McLoughlin (1997b) that did examine interaction from a teacher perspective compared five types of teaching interactions (social, procedural, expository, explanatory and cognitive) in five different live interactive television courses from secondary, post-secondary and vocational training sources in Western Australia. Their analysis found that in videoconferencing classrooms, the predominant types of interactions were expository and procedural. Unfortunately, no effort was made in this study to determine how that compared to traditional classroom teachers and if these dominant types of interaction were exclusive to videoconferencing teaching.

Influences on Classroom Interaction

Until now, theorists have tended to have an "if you build it, they will come" attitude about interaction in videoconferencing classrooms. Researchers have tended to theorize that giving more opportunity for student-teacher interaction would logically result in more interaction (Bauer & Rexabek, 1992; Boverie et al., 1997; Sholdt, Zhang & Fulford, 1995). However, this has not always been the case according to videoconferencing practitioners (Kelsey, 2000).

Moore (1993) has theorized that there are many influences on classroom interaction, including:

- number of students in the class,
- frequency of opportunity for communication,
- physical environments of both the teacher and learners,
- emotional environments of both the teacher and learners,
- personality, and
- content being taught.

Interaction is a complex system affected by many variables and simply building an environment where interaction is highly possible does not ensure that interaction will occur. A traditional classroom is an environment where interaction is easily encouraged, and yet classes can be highly interactive, or highly unidirectional depending on the teacher, students, course content or any of Moore's other factors outlined above. A study by Freeman (1998) that examined multi-campus videoconferencing at the University of Technology Sydney found that there was more time lost in videoconferencing classes due to technology problems and thus less interaction in videoconferencing classrooms. In another study of a post-secondary genetics course that was delivered from one site to five other sites via videoconferencing, Kelsey (2000) found that "the most significant and effective barrier to interactions was due to the limitations and failures of the ICV technology" (p. 69). The study found that technology failures caused by bad weather and human error resulted in a 36% decrease of student-teacher interaction compared to when the technology was working properly (Kelsey, 2000). In addition to the traditional influences on student-teacher interaction, teachers who teach in videoconferencing environments have technology factors working against them while trying to maintain levels of interactivity comparable to traditional classrooms.

The question that naturally arises from this point is whether or not classroom interaction is really that important to student learning. Bates (1995) has pointed out that a high degree of interaction may occur between a learner and an engaging book - sometimes more than in a less engaging classroom environment. Others have suggested that higher levels of interaction may actually negatively influence other relative constructs in distance education such a learner autonomy (May,1993). Studies of adult learners in videoconferencing courses (Stone, 1990, as cited in Threlkeld & Brzoska, 1994; Threlkeld & Brzoska, 1994) found that higher levels of interactivity do not necessarily result in better learning. However, many theorists and researchers have demonstrated the importance of interaction in student achievement (Holmberg, 1983, as cited in Shin, 2002; Moore, 1989, Stanford & Roark, 1974). One study of K-12 students using audiographic technologies in a gifted and talented program found that higher interactive learning environments were generally engaging and motivating for K-12 students (Oliver & McLoughlin, 1997a). Kelsey (2000) also found that although students didn't always take advantage of potential interaction, more opportunity for interaction did increase student satisfaction with the course, whether it was taken advantage of or not.

The Challenge to Teachers

Therefore, one of the major challenges for teachers teaching in videoconferencing environments is to create a learning situation that is comparable to, if not better than, the traditional classroom. In terms of interaction, this often means ensuring that lesson planning and implementation are performed in a way that maximizes potential interaction in videoconferencing environments. Reed & Woordruff (1995) warned that the alternative resembles how the average person responds to television; if we are not fascinated by what we are watching, we change the channel or tune out. They have suggested that "teachers who use two-way video must challenge basic learner preconceptions and set new expectations to maximize learning. Fortunately, good two-way video instructional strategies are also good classroom instructional strategies" (p. 3). Heath and Holznagel (2002) recently completed a literature review of videoconferencing practices in K-12 environments for 3 of the 6 Regional Technology in Education Consortia (R*TEC) funded by the US Department of Education. In that literature review, they came to the same conclusion and stated that according to the research, good classroom teachers generally make good videoconferencing teachers. Videoconferencing research and theory has repeatedly called for teachers to move away from the "talking head" model, however, that is not an ideal teaching method in traditional classrooms either (Motemedi, 2001). The "talking head" is simply bad pedagogy, regardless of the instructional environment in which it is occurring.

Even though good traditional teachers usually make good videoconferencing teachers, there are a number of additional skills that must be acquired to make be an effective teacher in a videoconferencing environment. For example, a number of expert practitioners have noted the importance of creating presence when teaching with videoconferencing (Cyrs, 2003a; Reed & Woodruff, 1995; Shin, 2002). Based on his many years of personal experience both teaching using videoconferencing and as a consultant for teachers using videoconferencing, Cyrs (2003a) has compiled an extensive list of skills that are needed to be a good videoconferencing teacher. Some of these skills include:

- using visualization techniques,
- using props,
- using good presentation techniques,
- using effective questioning with remote sites,
- creating interest,
- planning and managing remote site materials,
- planning and managing remote site activities,
- knowing copyright laws,

- correlating the technology and other instructional materials, and
- planning for evaluation (Cyrs).

The Impact of Videoconferencing Technology on Teachers

Most of the studies in the area of teaching using videoconferencing have focused on the impact the technology has on teacher planning. These studies have concluded that teachers who taught in videoconferencing environments were more organized and better prepared than traditional classroom teachers (Sullivan et al., 1994; Williams, Paprock & Covington, 1999). In their study of six videoconferencing initiatives in New Mexico, Oklahoma and Texas, Sullivan et al. (1994) also concluded that technology tended to produce a heightened consciousness of the teaching process, however, no studies have been conducted to explore this conclusion further.

Aside from the result on teacher planning, very little information is available about the impact of technology on teachers in videoconferencing environments. As Cyrs (2003b) pointed out, "students never learn from the technology. They learn from the way instructors communicate or show how to communicate through the technology" (¶ 26). In other words, students learn through the interaction that occurs through the technological medium. If there is no quantity of research on how teachers interact or behave when using videoconferencing technology, there is question as to how teachers can effectively gauge or be aware of the effects the communication methods they are employing are having on their students.

The Question of Teaching Style

Many theorists and practitioners have stated that teachers cannot transport one of their traditional courses directly to a videoconferencing classroom without significant modifications (Bates, 1995; Heath & Holznagel, 2002; Reed & Woodruff, 1995). However, the degree of modification required is a major question in the field. It is logical to assume that the videoconferencing medium dictates some modifications such as sending worksheets to remote locations ahead of time, however, researchers and theorists do not agree on what teaching styles are best used in videoconferencing environments. There is a great deal of debate as to whether or not a lesson taught using a lecture format in a traditional classroom can be as effective in a videoconferencing classroom. Some theorists and practitioners have expressed the belief that videoconferencing cannot be effective if it is simply a means of delivering a lecture and that maximizing interaction is of the utmost importance (Foley, 1998; Mason, 1998; Motamedi, 2001; Reed & Woodruff, 1995). However other theorists, notably Laurillard, feel that videoconferencing can be a very effective way to convey information using the lecture format. In her book on the effective use of distance education technology in universities, Laurillard (1993) stated that "video-conferencing invites the delivery of lectures... it is definitely a presentation medium as well as being a discursive one" (p. 167).

However, regardless of what videoconferencing teaching techniques should be, in a study of the use of the Charing Cross and Westminster interactive television network, Bollom, Emerson, Fleming and Williams (1989) found that lecture was by far the predominant method of instruction in videoconferencing on their network. A number of other studies reinforce this position (Freeman, 1998; Fillion et al, 1995). Unfortunately, these studies all focused on post-secondary institutions. This is likely at least part of the reason for the results, as lecture is usually the primary method of instruction in post-secondary undergraduate courses.

Theory vs. Practice

Overall, these issues point to the major flaw in prior videoconferencing research. There has been little work done to bridge the gap between theory and practice and many theorists have recognized this. As in many fields of study, there are two schools of thought relating to this debate. One school calls for a focus on asking basic, practical questions relating to the effectiveness of educational technology and its impact on learning (Tolsma, 1997; Wilson, 1997), while others call for a more integrated blend of theory and practice (Berge & Mrozowski, 2001; Chen & Willits, 1999; Heath & Holznagel, 2002; Machtmes & Asher, 2000; Moore, 1993, Moore & Kearsley, 1996).

In a meta-analysis of the effectiveness of distance education telecourses, Machtmes and Asher (2000) have called for the systematic identification and evaluation of the features of distance education technology that impact student learning and go beyond the theoretical models that have been proposed, but rarely examined in a practical setting. Chen and Willits (1999), researchers who have done a number of empirical studies to test some of the theoretical models of distance education (notably Moore's Transactional Distance Theory) have stated that more focus has been placed on student achievement and cost benefit analysis and less consideration has been placed on supporting and strengthening a theoretical basis for the field. They have argued that there is a "need for theory development to serve as a basis for systematic study, to contribute to conceptual insights about the complexities of distance education and to develop methods of enhancing the teaching-learning environment" (p. 45). Garrison (1993) put forth the following challenge to researchers in the field of educational technology:

> If distance education is to continue to develop as a field of study, then theoretical frameworks will have to be developed that recognize and reflect the differences between the dominant and emerging paradigms - not to artificially create a polarization but to ensure that in the complex world of practice decisions are made with awareness as to the ideals we are striving towards. Education is in essence a social learning experience that is not always compatible with prepackaged course materials designed to enhance private forms of learning. (p. 20)

Now that emergent paradigms like fully interactive two-way video (videoconferencing) are becoming mainstream, the need for a merging of theory and practice is more obvious than ever.

Transactional Distance Theory

One of the few theories of distance education to emerge from this debate was Michael Moore's Transactional Distance Theory (1973, 1993; Moore & Kearsley, 1996). This theory evolved from the work of Dewey (Dewey & Bentley, 1949) and his construct of transaction as a concept of how we learn. This has generally been the most comprehensive and accepted theoretical framework to emerge in this field (Chen & Willits, 1999; Heath & Holznagel, 2002).

In his theory, Moore (1993) proposes that education across a distance is more than just a geographical construct of distance, but a construct of pedagogy as well. This pedagogical construct, called transaction, is the interplay of individuals (i.e., teachers, learners, proctors) in and with the learning environment and the patterns of behaviour that are created from that situation (Heath & Holznagel, 2002). Moore proposed that these special patterns of behaviour could be classified as three core elements of distance education: autonomy (learner independence), dialogue (interaction between the teacher and learner) and structure (characteristics of course design). In Moore's own words:

> The transaction that we call distance education occurs between teachers and learners in an environment having the special characteristic of separation of teachers from learners. This separation leads to special patterns of learner and teacher behaviours. It is the separation of learners and teachers that profoundly affects both teaching and learning. With separation there is a psychological and communications space to be crossed, a space of potential misunderstanding between the inputs of instructor and those of the learner. It is this psychological and communication space that is the transactional distance. (p. 22)

There are two important qualifiers to this concept that apply particularly to videoconferencing. The first is that the constructs of transactional distances are not fixed, but relative based on the persons involved and the learning situation (Moore, 1993). As such, the transactional distance to be crossed from a teacher to learner 1 will be slightly different than the transactional distance to be crossed from that same teacher to learner 2. The second important point is that there is transactional distance in any educational program, even traditional face-to-face classroom environments (Moore, 1993). However, in a face-to-face environment, there is no instructional medium to influence that transactional distance.

Rather than only exploring the effects of a distance education medium like videoconferencing on learning, Moore (1993) has called for research into his three transactional concepts of autonomy, dialogue (interaction) and structure to identify the variables (attributes) that affect each of them. Moore has also noted that his original theory was created from research on correspondence learning and that new research must be conducted to explore the concepts of transactional distance in light of the changes that have occurred in distance education, particularly in the area of teleconferencing and other synchronous communications. Chen and Willits (1999), researchers who have done extensive empirical testing of Moore's Transactional Distance Theory, agreed. They stated that the recent trends towards telecollaborative technologies in distance education have created a need to modify and expand on the traditional conceptions of Moore's theories, especially in light of interaction (which Moore calls dialogue), since there are more opportunities for interaction in telecommunication environments compared with more traditional distance education media. They claimed that most of the research surrounding Moore's theories has been conducted outside of telecommunication technologies and have focused on learner autonomy. They felt that this was probably due to the general belief that self-directedness was long considered the hallmark of distance education, while interaction has been explored in a much more limited capacity until recently, as more interactive methods of communication have emerged.

Videoconferencing Research in the Area of Transactional Distance

A number of theorists and practitioners have answered Moore's call and have recently begun to examine practice in telecommunication environments in light of his transactional distance theory. After examining the theoretical and practical context of the research done on transactional distance in the field of videoconferencing, Heath and Holznagel (2002) have surmized that transactional distance in videoconferencing creates a separation that is significant enough to necessitate special teaching strategies. They claim that the literature has shown that "well conceived instruction and appropriate choice and use of media to overcome the problem of transactional distance are important" (p. 8).

In a more concrete exploration, Chen and Willits (1998; 1999) performed a factor analysis and a path analysis in their videoconferencing projects to examine the dimensions of educational transactions in videoconferencing learning environments. The factor analysis (Chen & Willits, 1999) explored the learning experiences of 121 post secondary students in 12 videoconferencing classes at Pennsylvania State University. The study concluded that all three of the central concepts of Moore's theory - dialogue, structure and learner autonomy - were influenced by a number of concrete factors and were often more complex in videoconferencing classes due to the complexity of the learning environment. This study was again based on post secondary students, though the generalizability of the complexity of the learning environment may apply to high school students as well. In their related path analysis based on the same 121 student questionnaires, Chen and Willits (1998) found that dialogue had a positive direct and indirect effect on learning outcomes and that transactional distance was inversely related to learning outcomes. Interestingly, they found that Moore's concepts of structure and learner autonomy had no significant effects on learning outcomes, with the only two significantly impacting factors being transactional distance between instructor and learners and frequency of in class discussion. However, these concepts did impact students' perceptions of transactional distance between them and their classmates both on and off site. Chen and Willits acknowledged that their path analysis may simply have not uncovered all of the significant relationships and they do discuss a number of types of replication that are needed to expand upon the study to determine if all three of Moore's constructs really do influence student learning in videoconferencing environments. Although this study does not offer any concrete results one way or another, it does move a step forward in demonstrating the necessity for practitioners to identify and evaluate core theoretical concepts in light of advances in distance education technologies.

The Emerging Construct of Transactional Presence

Recently, Shin (2002; 2003) expanded on theory in transactional distance as it relates to the concept of presence in videoconferencing. He proposed the concept of "transactional presence" which links the concept of presence to

Moore's transactional distance theory. He noted that "the concept of 'presence' has been studied from a variety of viewpoints in a number of fields of research, including communication, psychology, cognitive science, engineering, philosophy, art, etc., and yet the specific concept has not been articulated, operationalized or systematically studied" (p. 124). Shin (2003) defined the construct of transactional presence as:

> The degree to which a distance student perceives the availability of and connectedness with people in his/her educational setting. "Availability" implies that what is needed or desired is obtainable upon request involving the responsiveness of interpersonal relationships. "Connectedness" indicates the belief or feeling that a reciprocal relationship exists between two or more parties, involving an individual's subjective judgement upon the extent of the engagement in relationships with others. (p. 71)

The construct of transactional presence is therefore an attempt to integrate theories of presence such as social presence and telepresence into the world of distance education. It was "set forth as a theoretical construct to characterize distance student's perceptions of teachers, peers and institutions" (p. 132).

Unlike many theorists, Shin (2002, 2003) empirically tested his theory by administering a survey to post-secondary distance education classes at the Korean National Open University. In the analysis of 506 responses, he found that "the perceptions of psychological presence a distance student holds on the part of teachers, student peers and the institution can be significant predictors of their success in distance learning" (p. 79). A factor analysis also showed that both availability and connectedness were distinct but significantly correlated constructs. It is important to note that this study was based on all distance education courses at the Korean National Open University and that at the time of the study, videoconferencing was not one of the methods of distance education instruction. However, it is still highly possible that the construct of transactional presence applies to other methods of distance education where learners are separated and consequently may also be valid in a videoconferencing context. Shin (2003) acknowledged that the theoretical validity of his construct may have been limited and must be subjected to more analysis, however also he pointed out that understanding levels of transactional presence my be helpful in allowing institutions and teacher to evaluate the extent to which they are reaching their students, specifically in videoconferencing classrooms.

Other research supports Shin's (2003) preliminary findings. Chen (1997, as cited in Shin, 2003) found that when comparing students in local and remote groups (e.g., students in the same room as the teacher compared to students in classrooms at other locations), the teacher's physical presence positively influenced local students' participation in discussion and as a result, perceived learning achievement. A recent ten week study of 66 graduate students in a Master's level course at a UK university also found a significant difference between the learning experiences of students at remote videoconferencing sites and students at local sites when their attitudes and achievement were compared (Knipe & Lee, 2002). The study compared the experiences of 29 local students and 17 remote students using a self-observation schedule, and found that both attitude and achievement results were significantly higher for local students compared to remote ones. In another study of the perceptions of teacher presence on 185 students in middle school writing classes, Spaulding (1995) also found that students who had a stronger sense of psychological presence of the teacher were more engaged and performed better than students who had a weaker awareness.

Criticism of Videoconferencing Research in General

A number of recent studies have emerged criticizing the research on videoconferencing in general. In a review of the research done in distance education from 1990 to 1999, Berge and Mrozowski (2001) outlined the most common complaints about distance education research in general:

> Criticism often focuses on (1) noncontrol for extraneous variables, (2) lack of use of randomly selected subjects, (3) lack of validity and reliability of the instruments used to measure student outcomes, and (4) inadequate control for the feelings and attitudes of the students and faculty (i.e., 'reactive effects'). (p. 5)

The limited research that is available on videoconferencing specifically has also been subject to the same criticisms. According to Machtmes and Asher (2000), "studies that have compared distance instruction to traditional methods often have numerous methodological flaws including non-comparable instructional content, lack of a comparison group, and confounding effects due to different instructors (Clark, R. E. 1983; Moore & Thompson, 1990; Stickell, 1963)" (p. 28). Lockee, Burton & Cross (1999) also suggested that videoconferencing research is not overly generalizable because many stakeholders and investors have an interest in proving that participants in distance education programs receive the same quality of education as those who attend regular classes - that the quality of videoconferencing instruction is just as effective as face-to-face instruction.

They referred to these kinds of studies as comparative evaluations and stated that although these types of research studies are valid and likely useful for practitioners, "such studies must be published as local findings instead of generalizable contributions to the theoretical base of distance education" (p. 38).

The Media Debate

Supplementing these criticisms is the question of whether or not the instructional medium used has an impact on teaching and learning at all and whether research in this field is being done in a proper and meaningful way (Clark, 1993; 1994; Kozma, 1994).

In a theoretical discussion of transactional distance, Moore (1993) stated:

> It is obvious that the nature of each communications medium has a direct impact on the extent and quality of dialogue between instructors and learners. For example, an educational programme in which communication between teacher and learner is solely by one-way television, an audiotape, or simply a teach-yourself book, will have no teacher-learner dialogue simply because these media cannot carry messages from the learner to the teacher.... It should be apparent that this interactive nature of the medium of communication is a major determinant of dialogue in the teaching-learning environment. By manipulating the communications media it is possible to increase dialogue between learners and their teacher, and thus reduce the transactional distance. (p. 24)

This may be true, however Russell (1999) has shown that even if interaction is enhanced, it has little to no effect on student achievement or attitude. In recent years, he has documented what he calls the "no significant difference phenomenon" which states that in distance education, there is a predominant tendency for studies to show that the effects of an instructional medium have produced no significant difference on student achievement or attitudes when compared to traditional classroom methods. Studies have reinforced Russell's theory in the area of videoconferencing in particular, often finding that videoconferencing is at least as effective as traditional teaching methods (Heath and Holznagel, 2002; Simonson, 1997).

This is a positive finding for distance educators, however, there is still some debate surrounding the reasons for no significant difference findings. Some research hints that the "no significant difference phenomenon" may not be completely attributable to instructional medium and that this lack of significant difference could be because of teacher effort, rather than a lack of significant influence of instructional medium as has been commonly believed. In an extensive summary on the available research on effective instruction, Cotton (1999) has suggested that instructional effectiveness is a result of good instructional practice rather than being dependent on the medium of videoconferencing. Foley (1998) reinforces that belief, saying that distance education can be as effective as face-to-face instruction, assuming there are other appropriate methods in place such as appropriate instructional activities, a learner-centred focus and timely feedback. Finding no significant difference between instructional media is a valid and often positive finding for most researchers. The real question is that just how much instructional medium influences the "no-significant difference effect" is relatively unknown.

New Research in Media Studies

One must consider that if the research into videoconferencing has been so flawed and biased (Lockee, Burton & Cross, 1999; Machtmes & Asher, 2000) there is question as to whether media debate is valid or if this area simply requires further research that is less biased and better constructed methodologically. Another major problem with studies that have examined instructional medium is that they have been largely based on student attitude and achievement. There could be significant differences between media delivery methods that do not show up in student attitudes and achievement. In fact, studies that have looked at factors beyond student attitudes and achievement have shown that media do impact student behaviour (rather than attitude or achievement) significantly. In a study that randomly assigned 26 students to three different learning environments and had the same instructor deliver the same rehearsed material to the three groups, Ritchie & Newby (1989) found that student attention levels were generally down in the videoconferencing classroom because students were in a novel situation and had to deal with all of the new technology in the classrooms. Students were highly aware of the cameras, monitors and having to speak into the microphones and generally reported feeling less involved, like they were unable to ask questions and that they generally enjoyed the class less compared to the traditional classroom group and the studio classroom group. According to Stenerson (1999) other studies have shown that students' awareness of technology had a significant effect on their normal communication styles.

If technology has had a measurable impact on student attention and communication styles, it is reasonable to postulate that it may also have an influence on teacher communication style. Obviously there will be some differences dictated by the medium, such as the need for teachers to send worksheets ahead of time, however if student behavioural and communication techniques are impacted by technology, it is possible that teachers may also be influenced in those same ways.

Responses to Criticism of Videoconferencing Research

With this increased awareness of the criticisms of videoconferencing research, efforts are being made to improve research methodology. However, studies that can control for all three potential confounding possibilities are rare and difficult to construct due to the instructional demands inherent in the different types of media delivery. Due to this difficulty, Smith and Dillon (1999) have suggested that the confounding that often occurs when comparing distance education media like videoconferencing is an important and necessary element to examine when doing research into a distance education delivery medium. They stated that "rather than eliminating the media/delivery system-method confound, it should be recognized as a critical element in the research design and should be addressed by defining the instructional attributes made practical by particular delivery systems/media" (p. 10). Therefore, rather than trying to de-tangle the instructional attributes from the instructional medium, researchers should be examining what elements are naturally conducive to a particular delivery system so that they can be identified as an advantage of the medium. Scriven (1991, as cited in Furr & Ragsdale, 2002) suggested that this should be the direction of research in distance education - to examine what distance delivery programs are actually doing, and not whether they are meeting their intended goals or objectives.

Summary

A major fundamental issue with research in distance education and specifically videoconferencing is that there are significant issues relating theory to practice. There is little consensus on what should be done in videoconferencing classrooms and little effort has been made to prove or disprove theories that do exist. Most of the research has focused on cost-effectiveness and learner achievement and attitudes, likely in an attempt to justify the use of the technology to key stakeholders.

The research that has been done in videoconferencing from a theoretical standpoint has been largely based on Moore's Transactional distance theory (1990; 1993). This research has shown that videoconferencing environments are highly complex, especially where student teacher interaction was concerned. Further theory has stemmed from this research regarding the concept of transactional presence, though only a minimal amount of empirical research has been done in this area. Researchers have called for a more pronounced blend of theory and practice so that research in this area can contribute to a more concrete theory of distance education and contribute to theories involving videoconferencing in particular.

Unfortunately, much of the practice based research that has been done in the area of videoconferencing has been criticised as being poorly constructed and implemented. Critics have pointed out that there are often significant biases and confounding effects in research design. Furthermore, videoconferencing research has yet to show significant differences on student achievement and attitudes. Some researchers have pointed out that these findings are a positive indication that videoconferencing is as effective as traditional classroom teaching. However, some researchers have suggested that this lack of significant differences may be due to the poorly constructed research designs. They have suggested that to increase the validity of these studies, confounding must be controlled, and that confounding elements that cannot be controlled must be embraced as natural components of the videoconferencing medium.

The practice based research that has been done in the area of videoconferencing has also been criticized as being very one-sided. There has been a lack of research at the K-12 level, research that focuses on teachers and research on what is actually going on in videoconferencing classrooms as opposed to how it is affecting student attitude and/or achievement or meeting its intended goals. Although previous research has been done on student-teacher interaction in videoconferencing, most of the research has focused on the quantity of interaction from a student standpoint and not on the types of interactions and behaviours.

Despite evidence of bias and poor methodology in distance education research, there is evidence to indicate that examining the naturally occurring interactions within an instructional medium will reveal important information about the attributes inherent to that medium that do not necessarily relate to student achievement and attitude. Theorists have stated that there is reason to believe that instructional medium may influence special patterns of behaviour within a class or course. Research that has been done focusing on teachers using videoconferencing has shown that the medium has had a significant impact on their planning, and resulted in an increased awareness of teaching style, though again, little has been done to examine actual teaching behaviours.

In light of these findings, this study examined the verbal behaviours of a teacher who used both traditional and videoconferencing delivery on a daily basis. The study focused on the teacher in order to determine if there were any natural habits or techniques that were either consciously or unconsciously more conducive to the videoconferencing medium for the teacher, in order to foster an awareness of what this teacher is doing or not doing when she moves from instructional medium to instructional medium. The three common confounding factors described by Machtmes and Asher (2000) were addressed in that there was a valid comparison (the same teacher teaching the same course in the two environments), a common instructor, and the same course content delivered by that instructor.

This study is an attempt to link theory to practice by establishing a measure of the teaching behaviours that contribute to student-teacher interaction, which is one of the core components of Moore's Transactional Distance Theory (1993). Although this study was a descriptive case study and did not attempt to create any causal or correlational links, it is hoped that it may provide a justification for further research in these areas. It is also hoped that this study will provide potential insight and perhaps even generate further questions into areas of research such as transactional presence, the effect of remote and local groups, the effects of technology and medium on interaction, and the nature of student-teacher interaction in videoconferencing classrooms.

Chapter Three - Research Methodology

Research Problem

The purpose of this study was to examine the teaching practices of a teacher who was teaching the same class via videoconferencing and in a traditional face-to-face classroom, and to compare her verbal behaviours in those two environments. This study consisted of two components. A quantitative analysis was performed to determine whether or not there were any significant dependencies between the verbal classroom behaviours in the two environments. A qualitative analysis was also performed to identify any potential explanations for those differences as well as to examine whether or not the teacher was able to predict any differences in her verbal behaviours between the two environments.

The quantitative component of this study was accomplished by tallying the teacher's classroom behaviours in each type of classroom over a period of three days. The behaviours in each type of environment were compared using a chi-square analysis to determine whether or not there was an overall statistically significant dependency between what the teacher did when teaching in a traditional classroom, and the way she taught in the videoconferencing classroom. The chi-square was then partitioned to examine whether there was a statistically significant dependency in each of the individual behaviour categories that were recorded.

The qualitative analysis component of this study was done to explore any significant dependencies there may have been between the kinds of verbal behaviours in the two environments and to determine whether or not the teacher was aware of or able to anticipate any differences in her verbal teaching behaviours between the two environments. This was accomplished through a number of methods. A pre-study interview was conducted to provide some context for the study, as well as daily debriefing sessions after the classes each day. I also kept a reflective research log to note any relevant events or trends that I observed in the two environments throughout the course of the study.

Put simply, the problem that was examined in this study was to determine what differences, if any, there were between the verbal behaviours employed by a teacher in a regular classroom environment compared to the verbal behaviours employed by that same teacher in a videoconferencing classroom when the same course material was being taught. The variables examined went beyond the simple instructional methods that were being employed. For example, the videoconferencing system obviously forced the teacher to use certain techniques that were necessary due to the delivery medium, such as distributing handouts during the traditional class, but sending them to a proctor ahead of time for the videoconferencing classes. However, this study was more focused on the specific verbal behaviours between the teacher, students and even the environment based on which delivery medium the teacher was using. These verbal behaviours included elements such as the amount of verbal praise the teacher used, the amount of time that was spent helping students one-on-one, the amount of informal conversation with students and even how often the teacher talked to herself. Moreover, the study also examined whether or not any differences in verbal teaching behaviours were conscious or unconscious, that is, whether the teacher was able to predict whether or not she would use a particular verbal behaviour more frequently when using one delivery medium over another. It is hoped that this study may serve to foster an awareness of medium induced teaching style differences in other teachers who are teaching using different instructional media.

Research Questions

The above research problem was examined through a number of more specific research questions that were formulated to examine different categories of verbal behaviours in the classrooms:

1. What differences are there, if any, between the amount of time spent using *methods of direct instruction* in the two environments?
2. What differences are there, if any, between the amount of time spent using *methods of classroom management* in the two environments?
3. What differences are there, if any, between the amount of time spent in *formal questions, behaviours and interactions* in the two environments?
4. What differences are there, if any, between the amount of time spent in *informal questions, behaviours and interactions* in the two environments?
5. What differences are there, if any, between the amount of time spent in *student work and silences* in the two environments?

6. What other differences are revealed through the study?

The first five questions were examined through a number of variables derived from the quantitative instrument. The breakdown of these variables in light of the research questions is examined later in this chapter. Qualitative findings were also taken into account when examining the findings that related to each of these research questions.

The sixth category was examined predominantly through the qualitative analysis findings. This research question examined any differences that were noted in the study through observations and discussions with the teacher, rather than through the quantitative instrument. However, findings from the quantitative analysis were also used to support some of the discussions that arose from this research question.

Qualitative Instrumentation

As the interviewer and observer, I was the primary qualitative instrument in this study. No formal set of interview questions or observational guides were used in the qualitative analysis. My questions to the teacher were based on the behaviours that I observed in the different teaching environments.

I have had a great deal of involvement in the RACOL project for a number of years before this study. I was recruited by the principal investigator of the RACOL project to examine teaching best practices within the project, as well as to produce 'teacher friendly' instructional materials for the VPLE classrooms. As such, I have a strong basic understanding of the RACOL program and its goals, the equipment in the VPLE classrooms, and the underlying pedagogical ideals that were the foundation of the project.

I have also worked extensively with the teachers in the project, both in identifying their teaching best practices, and also as an observer participant in many of their professional development sessions. Over the course of the year and a half that I worked with the teachers before this study, I built a strong rapport with each of them as individuals and spent a great deal of time with them, listening to their struggles and successes teaching in the VPLEs.

I am also a certified teacher with experience teaching high school math, and specifically the same course that the teacher was teaching to the two classes in the two different environments. This gave me a strong awareness of the course content and any potential differences in the ways that the teacher presented material to her students in the two environments.

Quantitative Instrumentation

Many classroom observation instruments have been developed to observe classroom interactions and individual behaviours, including the Flanders Interaction Analysis System (FIAS) (Flanders, 1970), Foci for Observing Communication Used in Settings (FOCUS) (Fanselow, 1987) and Seating Chart Observation Records (SCORE) (Acheson & Gall, 1997) methods. For the purposes of this study, I decided to use the FIAS as an observational category system. I chose this instrument for a number of reasons. The primary benefit of the system was that it was easily administered and the coding was straightforward. Unlike other observation systems, the training to administer the FIAS was very straightforward and described in detail in Flanders (1970). Unlike more complex instruments, coding was simply a matter of recording what type of verbal behaviour was occurring in a set time interval. It was also an instrument that has been used a great deal in research, especially in the areas of teacher/counsellor observation (Jones & Figley, 1993; Kassner, 1998), training (Schempp, McCullick, St. Pierre & Woorons, 2004), and nursing/medicine (Kishi, 1983; Motohide & Wafer, 2004). Note that these are a very small number of the many studies that have employed this observational tool. The FIAS has also been modified for use in related fields of education, most notably by Cheffers (1977).

Variables

Since this study was a descriptive case study, the independent variable was not directly manipulated. It was simply the type of classroom environment in which the teacher was teaching: a traditional classroom or a videoconferencing classroom. Assuming a statistically significant dependency between teaching behaviours in the two environments, a more intricate causal-comparative or correlational study can be designed to examine these findings further. There was no comparison group for this study - it was simply the teacher herself that was being compared based on her verbal teaching behaviours and the student responses in the two different environments.

There were a large number of dependent variables in this study. They consisted of each of the elements that were recorded and tallied during the observations of the two classes (see Appendix A). These variables were based on the categories of the Flanders Interaction Analysis System (FIAS) (Flanders, 1970), which were subdivided to better meet the needs of my research questions by encompassing a broader range of verbal teaching behaviours. The original ten FIAS categories, as well as an explanation of why and how I modified them, are outlined in the section called Modification of the Instrument.

The dependent variables that emerged from the modified instrument were the amount of time that the teacher spent in:

Methods of Direct Instruction

1. Lecturing.
2. Preparing students for later.
3. Giving directions.
4. Correcting or clarifying ideas.

Methods of Classroom Management

1. Criticizing or asserting authority.

Formal Questions, Behaviours and Interactions

1. Asking formal questions.
2. Accepting feelings.
3. Praising or encouraging.
4. Accepting or using ideas.
5. Rejecting or not using ideas.

Informal Questions, Behaviours and Interactions

1. Asking informal questions
2. Initiating an informal story
3. Talking to self
4. Answering with an informal story

Different types of silences were also examined as dependent variables:

Student Work and Silences

1. Silence or confusion
2. Working silence
3. Informal silence

While the teacher was silent, student initiations and responses were also recorded and examined as dependent variables. These behaviours were recorded both to account for time and to provide a more holistic view of student teacher interaction in the discussion of the findings. However, these categories were examined in far less detail than the teacher behaviours and were simply divided into categories of formal and informal initiation and response. These variables were:

Formal Questions, Behaviours and Interactions

1. Student initiates formal interaction or question
2. Student responds to formal interaction or question

Informal Questions, Behaviours and Interactions

1. Student initiates informal interaction or question
2. Student responds to informal interaction or question

Further explanations of each of these 21 variable categories are outlined in the section on the modification of the instrument.

Hypothesis

Based on the research problem outlined above, the following general hypothesis was tested in this study:

H_o - There will be no difference in the number of occurrences of different types of verbal classroom behaviours in a videoconference classroom compared to a traditional classroom setting.

Because the data collection instrument was subdivided into a number of observational categories, there were also a number of smaller sub null hypotheses based on each observational variable from the data collection instrument. The results of the statistical tests on these hypotheses were then used to explore the six research questions outlined above. These sub null hypotheses were:

Methods of Direct Instruction

H_o1 - There will be no difference in the number of occurrences of the teacher *lecturing* in a videoconferencing classroom compared to a traditional classroom setting.

H_o2 - There will be no difference in the number of occurrences of the teacher *preparing students for later* in a videoconferencing classroom compared to a traditional classroom setting.

H_o3 - There will be no difference in the number of occurrences of the teacher *giving directions* in a videoconferencing classroom compared to a traditional classroom setting.

H_o4 - There will be no difference in the number of occurrences of the teacher *correcting or clarifying ideas* in a videoconferencing classroom compared to a traditional classroom setting.

Methods of Classroom Management

H_o5 - There will be no difference in the number of occurrences of the teacher *criticizing or asserting authority* in a videoconferencing classroom compared to a traditional classroom setting.

Formal Questions, Behaviours and Interactions

H_o6 - There will be no difference in the number of occurrences of the teacher *asking formal questions* in a videoconferencing classroom compared to a traditional classroom setting.

H_o7 - There will be no difference in the number of occurrences of the teacher *accepting feelings* in a videoconferencing classroom compared to a traditional classroom setting.

H_o8 - There will be no difference in the number of occurrences of the teacher *praising or encouraging* in a videoconferencing classroom compared to a traditional classroom setting.

H_o9 - There will be no difference in the number of occurrences of the teacher *accepting or using ideas* in a videoconferencing classroom compared to a traditional classroom setting.

H_o10 - There will be no difference in the number of occurrences of the teacher *rejecting or not using ideas* in a videoconferencing classroom compared to a traditional classroom setting.

H_o11 - There will be no difference in the number of occurrences of students *initiating formal interactions or questions* in a videoconferencing classroom compared to a traditional classroom setting.

H_o12 - There will be no difference in the number of occurrences of students *responding to formal interactions or questions* in a videoconferencing classroom compared to a traditional classroom setting.

Informal Questions, Behaviours and Interactions

H_o13 - There will be no difference in the number of occurrences of the teacher *asking informal questions* in a videoconferencing classroom compared to a traditional classroom setting.

H_o14 - There will be no difference in the number of occurrences of the teacher *initiating an informal story* in a videoconferencing classroom compared to a traditional classroom setting.

H_o15 - There will be no difference in the number of occurrences of the teacher *talking to herself* in a videoconferencing classroom compared to a traditional classroom setting.

H_o16 - There will be no difference in the number of occurrences of the teacher *answering with an informal story* in a videoconferencing classroom compared to a traditional classroom setting.

H_o17 - There will be no difference in the number of occurrences of students *initiating formal interactions or questions* in a videoconferencing classroom compared to a traditional classroom setting.

H_o18 - There will be no difference in the number of occurrences of students *responding to informal interactions or questions* in a videoconferencing classroom compared to a traditional classroom setting.

Students Work and Silences

H_o19 - There will be no difference in the number of occurrences of time spent in *silence or confusion* in a videoconferencing classroom compared to a traditional classroom setting.

H_o20 - There will be no difference in the number of occurrences of time spent in *working silence* in a videoconferencing classroom compared to a traditional classroom setting.

H_o21 - There will be no difference in the number of occurrences of time spent in *informal silence* in a videoconferencing classroom compared to a traditional classroom setting.

Participant Selection

The population for this study was any teacher who was teaching the same course in both a traditional and videoconferencing classroom within the context of the RACOL project. To provide the highest level of control in this study and to eliminate as much confounding as possible, it was essential to select a teacher who was teaching the same content in both teaching environments. As it turned out, only one of the four RACOL teachers was teaching the exact same course via videoconferencing as well as in a traditional classroom. Since this was the only teacher that met the criteria, she was both the population and the accessible population for the study. Fortunately, she was also described as a good teacher by a number of experts, including the principal of the distance learning program, the former superintendent of the school division, and the principal investigator of the RACOL project. Since this was a descriptive case study, I felt that it was important to study a teacher who was generally regarded as a competent and skilled teacher.

After ethics clearance was obtained (see Appendix B), the project was explained to the teacher in detail and she was asked if she would be willing to participate in the study. She agreed. In the past she had shown a great deal of enthusiasm for the RACOL project and all of the research endeavours that have resulted from it and she was again actively willing to participate in this study.

Methodology & Timeline

Once permission from the teacher had been secured, some time was spent building a frame of reference about the two courses. The teacher was teaching the same math course in the two different environments. The course being taught was a Grade 11 math course that focused on practical math application. The teacher taught the two courses on the same schedule (videoconferencing in block 3 and traditional in block 4) and taught from the same lesson plan in the two classrooms. Any variations were usually due to practical considerations that made modifications necessary for certain activities in one of the environments. For example, a lab activity that would have been possible in the traditional classroom might have had to be translated into an online simulation for the videoconferencing classroom. The traditional class had 12 students in it, while the videoconferencing class had 9 local students (that is, in the same school as the teacher), 2 students at one remote location and 3 at another.

The classes were technically 84 minutes each at the location the teacher was teaching from. The videoconferencing class began at 12:35 and ended at 1:59 and the traditional class began at 2:07 and ended at 3:31. However, it should be noted that in the videoconferencing classes, the remote schools were on slightly different schedules. The schools had not synchronized their clocks and therefore some classes started a couple minutes before or after the bell at the location the teacher was teaching from. This was also the case at the end of class, therefore, the codings for the classes did not measure exactly 84 minutes. This was also the case in the traditional classroom as the teacher sometimes dismissed her class a bit early or walked in a minute or two after the bell because she was performing an administrative task. In the end, the length of the 6 classes that were recorded ranged from 81 minutes to 84.25 minutes.

Due to financial restrictions, I was only able to be in the Fort Vermillion School Division for a week. The teacher was available to be observed four of the five days during the week of the study, therefore Monday was set as the pilot study day with Tuesday, Wednesday and Friday as the actual recording days. It was important to observe multiple days to account for any variances between days so that the total tallies in each of the categories would give a clear picture of what the teacher does "on average." It was also important that the observations be done for the same week in both environments to control for any potential differences in teaching style and/or content that may have occurred because I observed the two environments at different times. In the end, a tally of each of the teacher's verbal behaviours at set time intervals was performed in both environments on the same days. Those tallies were then summed and subjected to a test of statistical significance to determine if there were significant dependencies between the two environments.

Data Collection

A number of modifications were made to the data collection methodology prescribed in Flanders' Interaction Analysis (1970). Rather than using the matrix technique to study the sequence of interactions, I was interested in the total number of individual behaviours over time. This was because I was more interested in observing the number of occurrences of each of the categories as a means of determining how much time was spent engaged in each of the behaviours and whether certain behaviours were more conducive to one of the teaching environments over the other.

I also modified the actual coding process in that I changed the recommended coding time intervals. Flanders (1970) indicated that according to his method, coders would develop a coding tempo. He stated that:

> Observation continues at a rate of 20 to 25 tallies per minute, keeping the tempo as steady as possible. This usually works out to about one tally every 3 seconds. There is nothing magical about a 3-second period. An experienced observer, after considerable practice, tends to classify at this rate with this particular category system. A gifted observer might settle down to a faster rate, after considerable experience, and another category system might force a slower rate, even for a gifted observer. Having a regular tempo is much more important that achieving a particular rate because most conclusions depend on rate consistency, not on speed.... There is a tendency to increase rate of coding during rapid interchanges, especially if rare events are occurring... no observer is a perfect metronome. (p. 37)

Rather than code an average of every 3 seconds, I initially increased my time interval to 10 second. This worked well during my training and when coding lectures at a conference, however once I got into the classroom for the pilot test, it became apparent that 10 second intervals were far too large given the level of interaction the teacher maintained in her classroom. After a bit of trial and error, I settled on coding approximately once every 5 seconds. Coding every 3 seconds was too much for me to observe and record simultaneously, but 5 seconds was very comfortable and I was able to code at a consistent rhythm.

The final modification I made was that even though I was not a perfect metronome, I did have a perfect metronome guiding me in my coding. To maintain a consistent 12 codes per minute I used an electronic metronome that I listened to through earphones. The program was set to go off every 5 seconds to prompt me to code. As Flanders indicated, there were certain intervals that were a second longer or shorter due to the speed of the interactions or behaviours, but through the metronome, I was able to code consistently at 12 observations per minute.

Training

Before the pilot test I undertook the FIAS training process as outlined by Flanders (1970). There were three main components to my training. The first was the process of learning the coding differentiations. Flanders outlined each of the coding categories extensively as well as how to differentiate between them. He also outlined a number of short self-quiz type exercises in each of the categories to help the trainee determine whether or not they were coding correctly. Flanders also outlined three coding "episodes" which were teaching scenarios that had been properly coded according to his categories. The trainee could practice coding these episodes and then compare his or her results to "correct" answers as outlined in the book. This process was meant to further the trainee's ability to differentiate between the different code categories.

The second part of the training process was simply practicing coding in an authentic environment. As part of my training I practiced using the FIAS in a number of locations. The first was in a research methods course that I was in at the time, the second was while watching televised homework help sessions on public television and the third was at a conference shortly before the study began. These session allowed me to practice coding in three different instructional environments and gave me a variety of insights into the third part of the training process.

The final step of my training process was to "subscript" the categories to fit my study. According to Flanders (1970), "the word subscripting, as used here, means dividing a single category into additional subcategories" (p. 126). The purpose of subscripting is to provide additional data that focuses on specific research questions. According to Flanders, there are six steps involved in this process:

1. The major features of the research problem are identified,
2. concepts are outlined that account for these features and any relationships between them,
3. concepts are analyzed to identify a behaviour that will define them as a new subscript,
4. concepts and their resulting subscripts need to be evaluated and re-evaluated to identify practical discriminations that differentiate them,
5. methods of coding need to be identified for the new subscripts, and,
6. field trials must establish the utility of the new subscripts.

The first five steps of this process occurred over time as I performed the training and practiced coding in the different coding environments. Step 6 occurred both as part of those practice session, as well as through a pilot study day which served to verify that the subscripts that I had settled on fit with the teacher, her teaching style and the two teaching environments.

Modification of the Instrument

The instrument was subscripted for a number of reasons. The original FIAS observation schedule was not adequate to code a more interactive classroom environment, as it was originally created for a more structured second language environment. Flanders (1970) also did not differentiate between formal and informal interactions in his original categories, which was one of the main differentiations in my research questions. During the training process, I was initially noting differences between formal and informal behaviours within the original Flanders categories, however, I decided that it would be more beneficial to subscript the categories that were occurring both formally and informally into different categories. I also began taking notes in the margins of my observation sheet when I encountered a verbal behaviour that I felt either wasn't described specifically enough in Flanders or that related to my research questions and was happening frequently enough that I felt it was important to be differentiated from the core area it belonged to in Flanders' original schedule. As a result, I subdivided (i.e., subscripted) Flanders' original 10 categories into 21 categories so that I could account for a greater number of verbal behaviour types. These more specific coding categories allowed me to examine a greater number of behaviours in each of my research questions and to code with greater ease.

The FIAS as created by Flanders is outlined in Table 1.

Table 1. Original Flanders Categories

Original Flanders Categories		
Teacher Talk	Response	Accepts feelings
	Response	Praises or encourages
	Response	Accepts or uses ideas of
		Asks questions
	Initiation	Lecturing
	Initiation	Giving directions
	Initiation	Criticizing or justifying
Pupil Talk	Response	Pupil talk - response
	Initiation	Pupil talk - initiation
Silence		Silence or confusion

The types of behaviours that belong in each category were outlined extensively in his book *Analyzing Teaching Behavior* (Flanders, 1970). Each code was organized by whether it was a pupil or teacher initiation or response with both questions and silence as separate categories.

Table 2 shows the outline of the modified (i.e., subscripted) Flanders categories and how the new subscripted categories fit within the original Flanders model:

Table 2. Blended Original and Subscripted Flanders Categories

Original Categories		Subscripted Categories
1	Accepts feelings	Accepting feelings
2	Praises or encourages	Praising or encouraging
3	Accepts or uses ideas	Accepting or using ideas
		Rejecting or not using ideas
4	Asks questions	Asking formal questions
		Asking informal questions
5	Lecturing	Lecturing
		Preparing students for later
		Correcting or clarifying ideas
		Answering with an informal story
		Initiating an informal story
		Talking to herself
6	Giving directions	Giving directions
7	Criticizing or justifying authority	Criticizing or asserting authority
8	Pupil talk - response	Student responds to formal interaction or question
		Student responds to informal interaction or question
9	Pupil talk - initiation	Student initiates formal interaction or question
		Student initiates informal interaction or question
10	Silence or confusion	Silence or confusion
		Working silence
		Informal silence

Category 1, *accepting feelings* and 2, *praising or encouraging* remained the same.

Category 3, *accepting or using ideas*, was divided into two categories because Flanders' original category did not clearly allow for teachers to reject student ideas. It was subdivided into *accepting or using ideas* and *rejecting or not using ideas*.

Category 4, *asking questions*, was subdivided to reflect the nature of the questions as either lesson/school related or personal (e.g., how was your weekend?). It became two categories: *asking formal questions* and *asking informal questions.*

Category 5, *lecturing*, was subdivided into the largest number of categories. Though *lecturing* itself was the most common subdivision, there were a few differentiations that I felt should be made. The first was when the teacher was *preparing students for later.* She often referred to future topics, lessons and events to prepare them for what was ahead. It wasn't quite the same as lecturing since the content of what she was saying wasn't lesson related, it was simply to provide her students with a frame of reference. Examples of statements that would be coded as *preparing students for later* include:

- Next week you will be writing a quiz on this concept.
- This will become important later on when we learn about charting polynomials.
- You will have a sub on Thursday.

The second major differentiation was the concept of initiating new information in a lecture, versus responding to questions to clarify information. Flanders differentiated between initiations and responses in all of his original categories. To maintain this consistency in my categories, *correcting or clarifying ideas* was created to reflect when the teacher was responding to students, rather than initiating giving out new information. Almost all one-on-one student help was coded in this category, as were most of her answers during any question periods.

If she replied to a question but then began giving new information (e.g., it was turning into an initiation rather than a response) it was coded as lecture as soon as she began giving the new information, however, if she was just rephrasing or showing a new dimension of a concept she had already taught in response to a student question, it was coded as *corrects or clarifies ideas.*

Answering with a personal story and *initiating a personal story* were meant to reflect the amount of personal information the teacher gave out as part of her lesson. She often told personal stories that ranged in content from her experiences in math courses at University to what she had done the evening before. She was still initiating information to her students, but it was not formal knowledge content, therefore, I felt it should be separated from the rest of the lecture categories.

Finally, *talking to herself* was created to indicate that the teacher was informally talking to herself even though there was no real formal interaction going on with the students and no real knowledge content was being conveyed. This frequently occurred when the teacher had to fix technology problems (e.g., "maybe if I go like this… nope, that didn't work"), or when she was drawing a picture on the white board (e.g., "I'll just draw that here, like that, there we go").

Category 6, *giving directions* and 7, *criticizing or justifying authority* remained the same.

Categories 8 and 9, *pupil talk - response* and *pupil talk - initiation* were only subdivided to reflect the nature of those behaviours as either formal (lesson or school related) or informal (personal).

Finally, category 10, *silence or confusion*, was subdivided to reflect who was being silent and what type of silence was occurring. The category called *Silence or confusion* was a total silence when students had no activity they were supposed to be doing. For example, if there was silence when the teacher was trying to fix a technology problem, it would be coded as *silence or confusion*. *Working silence* meant that students and teacher were both silent, but the students had something they were supposed to be working on. It was purposeful silence. This would be coded if students were working silently on a worksheet or writing a quiz. *Informal silence* meant that the teacher wasn't talking, and the students could have been silent, but instead there was informal chatter. There was no real interaction going on between teacher and student, but it wasn't silent either.

These subdivisions allowed me to be far more specific when coding and to also examine a wider variety of categories that the instructional medium could potentially influence. The process of subscripting the FIAS allowed me to explore behaviours further than the original FIAS categories would allow me to, while still staying within the structure that Flanders (1970) had originally set out.

Pilot Test

The pilot test was conducted on Monday of the study week to verify that the instrument subscriptions and modifications to the observation process worked well with the teacher and her teaching style. Only a few minor modifications were made as a result of the pilot test. Although the metronome worked well to prompt me to code, it became apparent that the speed of the data collection needed modification. As outlined above, I required a number of different tests of different coding intervals to settle on coding every 5 seconds. Final modifications were also made to the instrument and naming of the subscripted categories was standardized.

Reliability and Validity

Unfortunately, due to ethical considerations, the observer reliability was not able to be tested in this study. It would have been desirable to video tape the lessons being coded in the traditional class and take the recorded video streams of the videoconferencing classes and then re-code them at a later time to compare them to my in-class codings in order to test my intra-observer reliability. Unfortunately, permission was not able to be secured in time from every student and their parent or guardian to video record the traditional classes or to use the video streams that were recorded in the videoconferencing classes for the purpose of this study.

However, it is still reasonable to make a number of claims about the reliability of the coding. First, reliability was likely positively impacted by the fact that I was the single observer on all of the days in both environments. Inter-observer reliability was thus not an issue. The actual observations occurred over a very short period of time (three days), so any decrease in intra-observer reliability from day to day was likely minimal. If there were issues with intra-observer reliability from day to day, it is reasonable to assume that since the classes occurred in pairs (i.e., two subsequent blocks) on the different days, any major changes in how behaviours were coded would have impacted both environments as time went on. However, intra-observer reliability may have been an issue in terms of each of the individual days. After coding for two 84 minute classes, it is possible that my coding was not as reliable at the end of the coding period as it was at the beginning.

Because I did not do the traditional matrix analysis that Flanders prescribed for his interaction analysis, it is difficult to make any authoritative claims about the validity of this study. However, as previously mentioned, the instrument itself has been widely used and adapted in educational research, as well as in other fields of study. As an observer, I went through the training process as outlined by Flanders and knew the coding differentiations well. Any modifications I made in my use of the instrument were in the form of subscripts of the existing categories, therefore validity was not likely influenced as those categories could be easily combined to result in the original 10 categories outlined by Flanders.

There was one obvious possible threat to validity in this study, aside of the possible sources of error and limitations of the study that were outlined in Chapter One. There was a possibility that the new technologically enhanced classrooms where the videoconferencing classes were held had a novelty effect on the teacher and/or students. Since the RACOL project was in its second semester of implementation at the time this study was performed, it is unlikely that the teacher was influenced by the novelty effect since she had already taught in the environment the previous semester. However, there may still have been a degree of novelty for students who had not taken classes using the medium during the previous semester. This study was conducted during the second week in March, when students had only been learning in the videoconferencing classroom for just over a month. The novelty of the different type of classroom environment may have impacted student behaviour and the results of this study may have been different had the students been taught in the environment for a longer period of time prior to the study occurring.

Analysis

At the end of the week, the codes from the three days were summed to establish the grand tallies of frequencies for the three days. Those frequencies were then subjected to a chi-square test for independence to test for overall statistically significant dependencies. The sums of the frequencies were used because the ratios of the category averages to total averages was the same as the ratios of the category sum to total sums, only three times larger. Since the chi-square is more robust when n is large, the larger sums were used rather than the smaller averages.

After the chi-square test for independence was performed to test for overall statistical significance, the chi-square was partitioned to look for statistically significant values within each of the individual coding categories. A further explanation and rationale for this process is outlined in the next chapter.

A qualitative analysis was also performed during this study. Various informal interviews were conducted with the teacher to determine whether or not she was aware of or able to predict any differences in her teaching and also what her feelings were about potential influences on her teaching behaviours. I also kept a reflective journal to record any observations that I felt were relevant to the study.

Error

There were a number of possible sources of error in this study. The first was that the teacher or students were influenced by my presence in the classroom. They may have acted or interacted differently knowing that they were being observed. This area of error is addressed in the qualitative analysis section of my discussion.

The second possible source of error was my coding of the different behaviours. Though precautions were taken to ensure that I was as accurate as possible, human error is always a possibility in observational studies. It is possible that I miscoded some behaviours or that the consistency of my coding decreased over time on each of the days.

The final possible source of error in this study is the course content, which was slightly different in the two classes. The teacher was obviously not able to replicate her first class exactly word-for-word in the second class, and there were therefore some slight differences in the lessons she presented to each of the classes. On the final day, there were also some slight differences between learning activities at the end of the class. These differences in content may have been the source of some of the differences that were found between teaching behaviours in the two environments. However, these differences were minor and took up a relatively small amount of time compared to the total number of tallies that were counted. There was a very reasonable degree of similarity in what was being taught in the two environments and slight differences in the words the teacher spoke likely did not drastically impact the teaching style and behaviours of the teacher. The differences that did exist are discussed Chapter 4.

Ethical Considerations

There were no real foreseeable ethical considerations for this study. There was no potential harm inflicted on the teacher or her students. The teacher was not evaluated, as I was only comparing her teaching style in one medium versus another. Though I was a live presence in the teacher's classroom, I was only there to observe her. Nothing was taped and no permanent record, other than my coding sheets, left the classroom. This study was approved by the ethics review board of the Faculty of Education at the University of Alberta (see Appendix B).

Summary

This study is a descriptive case study that examines the individual teaching behaviours that result from the verbal interactions between a teacher and her students in both a videoconferencing and traditional classroom. The independent variable for this study was simply the teaching environment (traditional or videoconferencing classroom) and the dependent variables were a number of behaviour categories that were based on the Flanders Interaction Analysis System (FIAS) instrument. These variables and their resulting hypotheses were used to explore the six main research questions in this study.

The participant was selected because she was the only teacher in the program who was teaching the exact same course in the two teaching environments. Her verbal behaviours were tallied for three days in each of the two teaching environments using the Flanders Interaction Analysis System (FIAS) as an observation schedule. For the purposes of this study, the FIAS was subscripted to more closely reflect the aims of my research questions and to reflect some of the more common behaviours observed in classrooms. These subscripted categories as well as other modifications of the instrument were tested during a one day pilot test. The data that resulted from the study were analyzed using a chi-square analysis and were further partitioned to explore significant dependencies between specific categories. Reliability and validity for the study were difficult to predict, but reasonable, especially considering the descriptive case study nature of the study, however it is possible that the novelty effect had an influence over the outcome of this study, as well as a number of other possible sources of error.

Sources of error in this study included the possibility that my presence influenced student and/or teacher behaviour, the potential of coding error and the possibility of different instructional content in the two classes. There were no major ethical considerations for this study and it was approved by the Faculties of Education and Extension ethics board at the University of Alberta.

Chapter Four - Data Results and Interpretation

Quantitative Data Results

The recorded tallies of the teacher's verbal behaviours during the three days of the study were subjected to a chi-square test for independence. This was the appropriate test for this data set because the data had a non-normal distribution and consisted of nominal categorical data tallies. A non-parametric test that would test for independence between the two environments was necessary and the data set fulfilled the requirements for the chi-square test for independence in that there was independence of observations and the size of the expected frequencies were reasonable. Any areas where the expected frequencies were in question are discussed in detail later on in this chapter.

The Overall Chi-Square Analysis

The overall chi-square test for independence tested the main null hypothesis:

> H_0 - There will be no difference in the number of occurrences of different types of verbal classroom behaviours in a videoconference classroom compared to a traditional classroom setting.

A significant chi-square value would mean that the two delivery media were not independent and that the teacher did interact differently with her students in the two different teaching environments. The level of significance for the rejection of the null hypothesis was set at a value of $\alpha = 0.01$. This would mean that a chi-square value of over 37.57 would result in a significant dependency that would allow for the rejection of the null hypothesis.

The Overall Chi-Square Analysis Results

The chi-square analysis was performed comparing the summed tallies of each of the 21 behaviour categories within the two different teaching environments (see Table 3).

Table 3. Observed vs. Expected Values for the Chi-Square

Category	Frequency	Traditional	Videoconferencing	Total
Lecturing	Observed	314	626	940
	Expected	468.6	471.4	940.0
Preparing students for later	Observed	28	32	60
	Expected	29.9	30.1	60.0
Giving directions	Observed	93	98	191
	Expected	95.2	95.8	191.0
Correcting or clarifying ideas	Observed	487	230	717
	Expected	357.4	359.6	717.0
Criticizing or asserting authority	Observed	90	19	109
	Expected	54.3	54.7	109.0
Asking formal questions	Observed	153	123	276
	Expected	137.6	138.4	276.0
Accepting feelings	Observed	2	4	6
	Expected	3.0	3.0	3.0
Praising or encouraging	Observed	32	33	65
	Expected	32.4	32.6	65.0
Accepting or using ideas	Observed	141	93	234
	Expected	116.6	117.4	234.0
Rejecting or not using ideas	Observed	31	20	51
	Expected	25.4	25.6	51.0
Student initiating formal	Observed	249	153	402
	Expected	200.4	201.6	402.0
Student response formal	Observed	274	174	448
	Expected	223.3	224.7	448.0
Asking informal questions	Observed	2	3	5
	Expected	2.5	2.5	5.0
Initiating an informal story	Observed	19	39	58
	Expected	28.9	29.1	58.0
Talking to self	Observed	24	78	102
	Expected	50.8	51.2	102.0
Answering with an informal story	Observed	21	58	79
	Expected	39.4	39.6	79.0
Student initiating informal	Observed	25	52	77
	Expected	38.4	38.6	77.0
Student response informal	Observed	23	36	59
	Expected	29.4	29.6	59.0
Silence or confusion	Observed	191	311	502
	Expected	250.2	251.8	502.0
Working silence	Observed	446	513	959
	Expected	478.0	481.0	959.0
Informal silence	Observed	313	281	594
	Expected	296.1	297.9	594.0
Total	Observed	2958	2976	5934
	Expected	2958.0	2976.0	5934.0

The analysis of the data resulted in a statistically significant chi-square value for the overall chi- square test, χ^2 (20, n=5934) = 404.115, $p<0.001$. Note that 4 of the cells had an expected frequency of less than 5. The chi-square test for independence can result in higher individual (non-summed) chi-square values when the expected frequency is less than 5. Category 1, *accepts feelings* and 8, *asking informal (personal) questions*, both had expected frequencies of less than 5. However, upon examining the non-summed chi-square values, it became apparent that these two categories did not significantly affect the overall chi-square value. If these categories were removed from the data set, and the chi-square test was performed without them, it would still result in a chi-square value of 403.266125 which is significant to $p<0.001$.

Since the chi-square value was significant and the error due to smaller expected frequencies was negligible, the null hypothesis was rejected and it was concluded that there was a significant dependency between how the teacher taught in the videoconferencing classroom, versus how she taught in the traditional classroom.

The Partitioned Chi-Square

Although knowing a dependency exists between the two types of teaching environments is useful, more useful information would be to know specifically which categories showed a significant dependency between the two environments. The data from this study were partitioned by extracting one category from the rest of the data and then performing a 2x2 chi-square test for independence (Weaver, 2003). For example, if we were testing for dependency for category 1, *lecturing*, the partitioned chi-square categories would be as shown in Table 4:

Table 4. Partitioned Chi-Square Sample

	Videoconferencing	**Traditional**
Category 1	Total from category 1 in the video-conferencing class	Total from category 1 in the traditional class
Categories 2-21	Summed totals from categories 2-21.	Summed totals from 2-21

This extraction of each category allowed me to examine if the ratio of frequencies between the videoconferencing classroom and the traditional classroom was significant when compared to the ratios of frequencies from the total of the data categories combined for each of the classroom environments.

The Partitioned Chi-Square Results

The partitioned chi-square tested the sub null hypotheses that were generated for each of the dependent variables. The results of these tests were used to examine the six specific research questions in this study. There was only 1 degree of freedom for this set of chi-square tests. The level of significance for these tests was again set at a standard value of $\alpha = 0.01$, which meant that a χ^2 value of 6.64 or higher resulted in a rejection of the null hypothesis. A number of categories in Table 5 resulted in a significant chi-square value:

Table 5. Partitioned Chi-Square Tests

Category		χ^2 Value	DofF	Asymp. Sig.
1	Lecturing	120.8119	1	0.000**
2	Preparing students for later	0.2454	1	0.620
3	Giving directions	0.1057	1	0.745
4	Correcting or clarifying ideas	106.5608	1	0.000**
5	Criticizing or asserting auth.	47.5534	1	0.000**
6	Asking formal questions	3.6135	1	0.057
7	Accepting feelings	0.6553	1	0.418
8	Praising or encouraging	0.0100	1	0.920
9	Accepting or using ideas	10.5559	1	0.001**
10	Rejecting or not using ideas	2.4609	1	0.117
11	Student initiated formal int.	25.2202	1	0.000**
12	Student response formal int.	24.8052	1	0.000**
13	Asking informal questions	0.1941	1	0.659
14	Initiating an informal story	6.8427	1	0.009*
15	Talking to self	28.7561	1	0.000**
16	Answering with informal story	17.3363	1	0.000**
17	Student initiated informal int.	9.4268	1	0.002*
18	Student response informal int.	2.8141	1	0.093
19	Silence or confusion	30.5463	1	0.000**
20	Working silence	5.1090	1	0.024
21	Informal silence	2.1375	1	0.144

** Significant at the 0.001 level *Significant at the 0.01 level

As shown, nine of the eleven statistically significant values were significant to $p<0.001$ or better. The two that remained were significant to $p<0.01$.

Null Hypotheses of the Sub-Categories

The null hypothesis for categories 1 and 8 could not be rejected. Both categories had expected values of less than 5 in over 20% of their cells, therefore, the basic requirements for the chi-square test were not met in those categories. However, this does not affect the overall results of the study significantly as neither of these categories had statistically significant chi-square values.

Well over half of the remaining categories had statistically significant dependencies which resulted in a rejection of the null hypothesis. These categories, along with the categories that had no significant dependencies, are listed below as they relate to the research questions:

1. What differences are there, if any, between the amount of time spent using *methods of direct instruction* in the two environments?
    - Lecturing: χ^2 (1, n=5934) = 120.8119, p<0.001 (higher in the videoconferencing class).
    - Preparing students for later: No significant dependency.
    - Giving directions: No significant dependency.
    - Correcting or clarifying ideas: χ^2 (1, n=5934) = 106.5608, p<0.001 (higher in the traditional class).
2. What differences are there, if any, between the amount of time spent using *methods of classroom management* in the two environments?
    - Criticizing or asserting authority: χ^2 (1, n=5934) = 47.5534, p<0.001 (higher in the traditional class).
3. What differences are there, if any, between the amount of time spent in *formal questions, behaviours and interactions* in the two environments?
    - Asking formal questions: No significant dependency.
    - Accepting feelings: No significant dependency.
    - Praising or encouraging: No significant dependency.

- Accepting or using ideas: χ^2 (1, n=5934) = 10.5559, p=0.001 (higher in the traditional class).
- Rejecting or not using ideas: No significant dependency.
- Student initiates formal interaction or question: χ^2 (1, n=5934) = 25.2202, p<0.001 (higher in the traditional class).
- Student responds to formal interaction or question: χ^2 (1, n=5934) = 24.8052, p<0.001 (higher in the traditional class).

4. What differences are there, if any, between the amount of time spent in *informal questions, behaviours and interactions* in the two environments?
   - Asking informal questions: No significant dependency.
   - Initiates an informal story: χ^2 (1, n=5934) = 6.8427, p=0.009 (higher in the videoconferencing class).
   - Talking to self: χ^2 (1, n=5934) = 28.7561, p<0.001 (higher in the videoconferencing class).
   - Answering with an informal story: χ^2 (1, n=5934) = 17.3363, p<0.001 (higher in videoconferencing).
   - Student initiates informal interaction or question: χ^2 (1, n=5934) = 9.4268, p<0.002 (higher in videoconferencing)
   - Student responds to informal interaction or question: No significant dependency.
5. What differences are there, if any, between the amount of time spent in *student work and silences* in the two environments?

- Silence or confusion: χ^2 (1, n=5934) = 30.5463, p<0.001 (higher in videoconferencing).
- Working silence: No significant dependency.
- Informal silence: No significant dependency.

Qualitative Data Results

A qualitative analysis component to this study was undertaken for two reasons. The first was to provide some context for the results and explore any explanations other than the instructional medium that could account for any statistically significant dependencies. The second was to gauge whether or not the teacher was accurately aware of any differences in her teaching behaviours between the two environments.

Data for the qualitative analysis were obtained in three ways. The first was through a telephone interview that was conducted before the study began. The second was through a series of debriefing sessions that were conducted at the end of each day that classes were observed. The third source of qualitative data was a research log that I kept throughout the week. Though I was far too consumed with coding to record observations as the classes were occurring, I did record any observations that I felt were relevant at the end of each class and again at night after reflecting on the day's lessons.

The first section of this qualitative analysis examines potential explanations for any statistically significant dependencies between the teacher's behaviours in the two environments. The second section addresses the teacher's predictions of any differences between the two environments.

Potential Explanations for Differences - Teacher's Perceptions

The teacher made a number of observations about the differences that she saw between the two classes in general. It should be noted that when I asked her at the end of the week how she felt the classes went, she did not indicate that the classes that week were anything but "normal". Even on the Friday afternoon when her students were acting up a bit, she indicated that it was typical behaviour for both of the classes.

The first major difference for the teacher was that she indicated that she liked the videoconferencing class better than the traditional class. Because the videoconferencing classes were in their first year of implementation, the local students in the videoconferencing classes had been hand picked by administrations as "good" kids who could handle the independent work that would be required if they took the class via videoconferencing rather than in one of the traditional classrooms. As a result, she felt she had far fewer classroom management and discipline problems in the videoconferencing class and even expressed the opinion that she liked teaching the class better than teaching the traditional class. It is interesting to note that even though "good" students were selected to be in the videoconferencing classes, the teacher reported at the end of the semester that there was no difference between the final achievement results of the two classes. These findings were validated by data obtained from the school district at the end of the semester. A t-test performed on the two sets of class marks showed no significant difference between the students' final marks (see Table 6).

Table 6. T-Test for Equality of Means of Student Achievement

Environment	n	Mean	Std. Dev.	Std. Error Mean	t	df	Sig. (2-tail.)
Traditional	11*	54.91	15.76	4.75	1.240	20	.229
Videoconferencing	11*	46.45	16.21	4.89			

* Note that n is the number of students who finished the course. Throughout the semester, a number of students dropped out of each of the courses.

During the course of the study I noted quite frequently in my research log that the teacher appeared to have far more informal interactions with the students in the videoconferencing classroom. However, this only appeared to happen with the local students. I noted fewer informal interactions occurring between her and the remote students. She also often chatted quietly with local students at the end of the class, while students at remote locations continued working.

The teacher also said that she felt most activities took longer in the videoconferencing classrooms. This was because there were many technical problems, almost on a daily basis, and she felt that those problems increased the length of time it took to perform many tasks and activities in the videoconferencing environment. When I asked her what she felt the extra time was taking away from, she said that she wasn't sure, but that there was certainly an imbalance between how long it took to do things in the two classes.

However, even though she felt there were drawbacks to the videoconferencing medium, the teacher also felt that it led to a number of other positive results. She felt that the videoconferencing classes were naturally more structured and as a result, she felt that there was less of a need for classroom management in those classes. She also felt that because the videoconferencing system was able to zoom in on students, many students did not want to have attention drawn to them, which might have had a positive influence on the students in terms of classroom management. She did note however that remote students tended to skip more frequently in her videoconferencing classes. She felt that this might be because it was harder to track down remote students and follow through with consequences in that teaching environment.

One interesting note that I asked her about was that I noticed that she left the traditional classroom far more frequently than the videoconferencing class. She said that she felt she had more freedom to leave her traditional class and that she felt she had to stay in the videoconferencing classroom because she felt responsible for her remote students. This raises an interesting issue about the teacher's locus of control in the two environments. It was interesting that she felt more free to leave an environment where she had more control to do something if something went wrong, and yet felt she was responsible to stay for the students in an environment where she had much less control over being able to do anything if things went wrong.

Potential Explanations for Differences - Class Content

During the initial interview, the teacher stated that she kept the class content synchronised to avoid cheating, (e.g., students sharing quizzes and homework) and other logistical problems. Wherever possible, she kept the exact same instructional content unless one medium restricted that in some way. She felt that planning and marking were easier for her that way. Both classes were starting the Math unit called Functions and Relations on the Monday that I arrived. The topics covered during my week there consisted of:

Pilot test:	3.1 Interpreting and creating graphs.
Day 1:	3.2 Graphing from tables of data, and
	3.3 Graphing from equations.
Day 2:	3.4 Representing functions in many ways.
Day 3:	Weekly quiz , and
	3.5 Domain & Range (videoconferencing class only).

With the exception of day three, which is described in detail below, the teacher appeared to do the exact same examples, notes, activities and worksheets in the two classes.

During my observations of her classes I only noted two times when instructional content was different. The first was during the pilot study and was therefore not relevant to the findings of this study. The second instance was of more practical importance since it may have affected the results of this study. The difference was during the third day of recorded classes. After the students had finished a quiz, the teacher began teaching the next topic in the videoconferencing classroom while in the traditional classroom she had them begin a worksheet. This difference spanned approximately 15 minutes of the 84 minute block.

Another major difference was not a direct result of course content, but it was part of the content of the lesson. I noted in my research log that there were a number of times when there were technology problems that the teacher had to spend time dealing with. The most notable instance being a day when one of the remote classes couldn't hear her teaching for a good portion of the class. The teacher had to leave the class to go call for technical support for the remote location. During those times when technology was causing problems the codings were exclusively *silence/confusion* or *student talk*.

Potential Explanations for Differences - My Presence

Another possible explanation for differences between the two environments was my presence. Even thought it was stressed to students that I was only there to observe how their teacher taught, and not them individually, it is possible that my presence affected one or both groups of students, which may in turn have affected the way the teacher interacted with them.

As a classroom teacher, I saw a great deal of evidence to indicate that I likely did not influence student behaviour significantly. Below is an excerpt from my research log from the first day of coding:

> I don't believe the students are behaving differently because I'm here. Today when [teacher] left the classroom they were so bad and were watching at the door for her. When she started coming back they whispered "she's coming" and ran to their desks. I was glad to have

> witnessed this because it reassured me that my presence is likely not overly intrusive or influential.

As each day passed, I noticed that this occurred in both of the teaching environments, though not as drastically as on that first day. In both environments the students would begin talking when the teacher left the room (often in ways that teachers would likely consider inappropriate) and stop immediately when she returned. It is my opinion as a teacher that the students would not have spoken the way they did when I was there if I was affecting their normal behaviour in a significant way.

It is also possible that my presence influenced the teacher, however, it is highly likely that if it did influence her, it influenced her in both environments and therefore did not result in any significant differences between how she acted in the two environments.

Teacher Predictions

After the initial pilot test and before coding began I asked the teacher to make some predictions about the outcomes of the study during one of our debriefing sessions. She was asked whether she felt each category was done more in the traditional classroom, more in the video classroom or was about the same in both environments. The results of her predictions of which class would be higher are displayed in Table 7. Note that the teacher chose to opt for one environment over the other and never actually chose "about the same" for any of the categories.

Table 7. Teacher Predictions of Significant Dependencies

Category	Prediction	Actual
Lecturing	Videoconferencing	Videoconferencing
Preparing students for later	Videoconferencing	NSD
Giving directions	Videoconferencing	NSD
Correcting or clarifying ideas	Traditional Class	Traditional Class
Criticizing or asserting authority	Traditional Class	Traditional Class
Asking formal questions	Videoconferencing	NSD
Accepting feelings	Traditional Class	NSD
Praising or encouraging	Videoconferencing	NSD
Accepting or using ideas	Videoconferencing	Traditional Class
Rejecting or not using ideas	Videoconferencing	NSD
Student initiates formal interaction	NA	NA
Student responds to formal interaction	NA	NA
Asking informal questions	Traditional Class	NSD
Initiating an informal story	Videoconferencing	Videoconferencing
Talking to self	Traditional Class	Videoconferencing
Answering with an informal story	Videoconferencing	Videoconferencing
Student initiates informal interaction	NA	NA
Student responds to informal interaction	NA	NA
Silence of confusion	Videoconferencing	Videoconferencing
Working silence	Videoconferencing	NSD
Informal silence	Traditional Class	NSD

NSD = No significant dependency

The teacher was able to predict the behaviour differences correctly in 6 out of 8 of the categories that had a significant dependency between teaching environments. Unfortunately, there was no way to determine if this was because she was aware of how the instructional medium influenced her teaching behaviours, if she was aware of how another factor, such as her different students, influenced her teaching behaviours, or if she just made some very educated guesses on the spot.

Summary

The quantitative analysis found a significant dependency between the overall teaching behaviours in the two different learning environments. The partitioned chi-square analyses revealed a number of individual categories with significant dependencies which were outlined in Table 5. The remainder of the categories had no significant dependencies and the null hypothesis was retained for those categories.

The qualitative portion of the analysis revealed that the teacher was quite accurate at predicting the differences between her behaviours in the two environments as she was able to correctly predict 6 of the 8 categories that had a significant dependency between environments. The qualitative analysis also revealed a number of factors that the teacher felt may have influenced her teaching behaviours and interactions with her students. A discussion of how those factors may have influenced the significant dependencies found in the quantitative analysis is outlined in the following chapter.

Chapter Five - Discussion and Conclusions

Structure of the Discussion

This section begins by examining each of the first five specific research questions as they were presented in Chapter Three, as well as the significant dependencies that were found within each of those sections. Next, I examine the categories that did not have any significant dependencies and discuss the implications of those findings. Finally, in the teacher prediction section, I discuss the teacher predictions from the qualitative analysis and discuss possible explanations for any differences in findings.

In the General Discussion section I discuss how the findings of this study relate to the current literature, both in terms of the five specific research questions, as well as through any other findings that arose from the qualitative analysis (which was my sixth research question). In the section on practical significance and implications I make any possible claims that result from this study as well as present a model that I feel reflects the nature of the behaviours that occurred in the videoconferencing classroom. Finally, I discuss the potential research questions that arise from both the qualitative and quantitative findings of this study.

Discussion of Significant Dependencies

Even though there were statistically significant dependencies in a number of behaviour categories, it is important to examine those findings in light of the information obtained in the qualitative analysis. It is naïve to assume that instructional medium within the classroom environment would be the only influence over the teacher's interactions. Examining the data in light of the qualitative analysis will hopefully give a clearer picture of the complexities of influences and whether or not some influence can be attributed to instructional medium.

Methods of Direct Instruction

A major difference in this study were the methods of direct instruction in the two environments. The two most highly significant results in the whole study were for *correcting or clarifying ideas*, χ^2 (1, n=5934) = 106.5608, p<0.001, and *lecturing*, χ^2 (1, n=5934) = 120.8119, p<0.001. However, these categories were significant in opposite environments. Lecturing happened far more frequently in the videoconferencing environment (21.03% of the time) compared to the traditional classroom (10.62% of the time). Conversely, correcting or clarifying ideas, which was the more one-on-one responsive type of instruction was far more frequent in the traditional classroom (16.46% of the time) compared to the videoconferencing classroom (7.73% of the time). These findings also indicate that students in the traditional classroom were likely getting more one-on-one instruction, while students in the videoconferencing classroom were getting significantly more large group instruction.

These findings again support the studies that claim that videoconferencing is a less interactive environment (Freeman, 1998; Kelsey, 2000; Ritchie, 1993). Because there were no significant differences in achievement between the two classes, the data also supports the claims that higher interaction does not necessarily result in better learning (Bates, 1995; Stone, 1990, as cited in Threlkeld & Brzoska, 1994; Threlkeld & Brzoska, 1994).

It is likely that medium has somehow influenced this set of results. As mentioned above, many studies have shown that individual student interaction decreases in videoconferencing environments. This could easily explain why students were getting more large group instruction in the videoconferencing classroom. It is also interesting to note that the teacher accurately predicted this difference in her instructional method, even though when the results of the study were relayed to her after the statistical analysis was performed, she expressed surprise at the degree of difference between the two categories, even though she was able to predict the difference accurately. The question that arises is if the teacher is conscious of this disparity, does she allow it to continue consciously and if so, why? Her instructional content (i.e., notes and examples) were exactly the same in both classes, so how did she manage to lecture twice as much in the videoconferencing classroom? It is possible that things she would normally clarify to individual students in a traditional class, she lectured to the whole group in the videoconferencing class. Perhaps she was aware (either consciously or not) of the lower interaction and the decreased likelihood of videoconferencing students initiating formal interactions. It is also possible that the teacher felt more responsible to make sure the students at remote locations had as much knowledge as she could give them from afar, similar to the sentiment she expressed during interviews that she did not feel she could leave the videoconferencing classroom as freely because she felt more responsible for the remote students.

Methods of Classroom Management

The teacher used classroom management techniques significantly more in the traditional classroom, χ^2 (1, n=5934) = 47.5534, p<0.001. This again could be attributed to either the students or the instructional medium. In my interviews with her, the teacher mentioned that students were "hand-picked" by administration to be in the videoconferencing classes. They were students that administration felt could handle the more self-directed nature of being in a videoconferencing class. According to the teacher, this meant that the students in the videoconferencing class were often better behaved kids. This alone may have caused the statistically significant dependency in the amount the teacher criticized or asserted her authority.

However, the teacher also expressed the feeling that the videoconferencing classroom itself made for a more structured classroom environment and was conducive to less classroom management. The buttons and audio system meant that a student speaking out didn't distract her or the other students, and any disobedient behaviour was simply less distracting overall in the videoconferencing environment. This could be another possible reason for the significant dependency.

From my observations in the classes, there was one student in particular in the traditional class who was the source of most of the teacher's classroom management interactions. In my opinion, that student alone may have caused the statistically significant dependency between the two environments. If the videoconferencing classroom does provide more structure than a traditional classroom as the teacher expressed, it would be interesting to see how this student in particular would behave in a videoconferencing classroom, rather than in a traditional classroom environment.

One other comment regarding classroom management is that the teacher noted that students in her videoconferencing class skipped class more often that her traditional students did. This may be another issue of control; it is much harder for the teacher to track down students from hundreds of kilometres away, whereas it is much easier to track down students who are in the same school. It is interesting to note that both groups of students were being "disobedient," but in different ways, which may have been partially due to the limitations and attributes of the teaching medium that was being used.

Formal Questions, Behaviours and Interactions

A number of the formal student questioning categories had highly significant dependencies that indicated that there was far more formal interaction in the traditional classroom. However, that interaction was not due to the teacher initiating it more often. The results showed no significant dependencies between how often the teacher asked formal questions, however, formal student initiation was significantly higher in the traditional classroom, χ^2 (1, n=5934) = 25.2202, p<0.001, as was formal student response, χ^2 (1, n=5934) = 24.8052, p<0.001.

There was also accepting or using student ideas significantly more in the traditional classroom, χ^2 (1, n=5934) = 10.5559, p=0.001. This could have been a direct result of the students initiating and responding to formal interactions significantly more in the traditional classroom. If students were initiating more interactions the result may have been that there were more ideas presented by students, and the teacher was able to accept more of those ideas from students as well as have more students respond to her comments and those of their peers.

The real question, however, is whether these results can be attributed to instructional medium. It is quite possible that the students in the traditional classroom were simply more verbal than the students in the videoconferencing class. It is also possible that the students in the traditional classroom simply needed more clarification of ideas, which is why they initiated more formal interactions. However, it is also possible that the videoconferencing class simply did not initiate more interactions because of the instructional environment. This would support the studies that have shown that student interaction is often less in videoconferencing classrooms (Freeman, 1998; Ritchie, 1993; Kelsey, 2000) and that even if the opportunity for interaction exists, students do not always take it (Kelsey, 2000). These findings also support those earlier claims that videoconferencing teaching is less interactive than a traditional classroom (Ritchie, 1993; Kelsey, 2002), regardless of the fact that the teacher taught the same content and had no significant dependency in the number of questions she asked her students in the two environments.

Informal Questions, Behaviours and Interactions

Although formal behaviours were significantly higher in the traditional classroom, informal behaviours were significantly higher in the videoconferencing classroom. The teacher more frequently answered with a personal story, (χ^2 (1, n=5934) = 17.3363, p<0.001), and initiated a personal story (χ^2 (1, n=5934) = 6.8427, p=0.009) in the videoconferencing classroom. Students also initiated informal interaction significantly more in the videoconferencing classroom, χ^2 (1, n=5934) = 9.4268, p=0.002.

This category, however, was likely strongly influenced by the fact that there was a remote and local group in the videoconferencing classroom. It is possible that this result can be explained because the teacher made an effort to build community among her local and remote students. Teachers received extensive professional development training about how to build community in their classrooms and these results may have been the result of that effort by the teacher. It is also possible that this degree of informal interaction was a result of Shin's (2002; 2003) construct of transactional presence. If the teacher were conscious of not feeling connected to her students, she may have compensated by having more informal interactions with them.

However, based on my observations, it is more likely that this finding was a result of having a local group in front of her. The teacher stated that she enjoyed the videoconferencing students more and that they were better behaved students and over half of them were in the same classroom that she was in. I noted in my research journal that the teacher spent far more time engaged in informal conversation with the local group during work time (i.e., when they were working on math problems at the end of the class). If there had been no local group, it is quite possible that this category may have had no significant dependency or even been in favour of the traditional classroom.

An interesting and even puzzling significant dependency was the amount of time the teacher spent talking to herself in the videoconferencing classroom χ^2 (1, n=5934) = 28.7561, $p<0.001$. This might be explained by the number of technical problems that occurred, as I did note that she tended to talk to herself when she was troubleshooting, however, she also spoke to herself when she was drawing charts and illustrations for notes, as well as when she was frustrated with students (which appeared to occur more often in the traditional classroom). One possible explanation is that talking to herself was the result of her perception of her remote students. It could be that any sort of transactional distance that she felt needed to be overcome (Heath & Holznagel, 2002; Moore, 1993) or that she felt a lack of transactional presence (Shin, 2002; 2003) either of which may have unconsciously motivated her to verbalize her thoughts more frequently to bridge the gap between her and her remote students.

Student Work and Silences

Although there was no significant dependency between the amount of informal silence (or student talk) and working silence, there was significantly more silence or confusion (χ^2 (1, n=5934) = 30.5463, $p<0.001$) in the videoconferencing classroom. Note that *silence or confusion* was purposeless silence, while *working silence* was silence while the students had something they were to be doing, like problems from their textbook. *Informal silence* was when students had nothing to do, but rather than being silent were chatting informally amongst themselves.

This difference was likely related to the instructional medium. Students tended to be silent when there were technical problems that the teacher was troubleshooting and while she was changing the equipment she was using to present. Another potential explanation was that there were also far fewer peers for students to interact with. Students in remote schools could not interact with other locations without using the buttons in the VPLEs and the remote groups were much smaller than the group in the traditional classroom. There were simply less opportunities for students to interact with each other and less students to interact with.

The teacher also noted that she felt that the videoconferencing classroom resulted in a more structured class, which may have resulted in more silence and less informal chatting, even when students didn't have anything they were supposed to be doing. It is possible that the students themselves were also an influence in this difference. The teacher noted that these students were hand-picked by administration as "good" students. This may have also have meant that they spent less time chatting informally and more time waiting in silence.

It is interesting to note that even though the videoconferencing students spent more time in silence or confusion, the videoconferencing classroom also had a higher proportion of overall informal interaction. When you total all of the informal interaction categories 8.94% of the total classroom time in the videoconferencing classroom was spent in informal interaction, while only 3.86% of the total classroom time in the traditional classroom was spent in informal interaction.

No Significant Dependencies

Although there were many significant dependencies between the ways that the teacher taught in the two different instructional environments, it is useful to also examine those categories that had no significant dependency to examine what is happening consistently despite the different instructional environments.

Two of the main categories of teacher response to student initiations were roughly equivalent: *praising or encouraging* and *rejecting or not using ideas*. Despite the different instructional environments, the teacher's opinions about her different classes, and the different amounts and types of classroom management in them, she was consistent in how she rejected ideas and praised or encouraged her students. If anything, this likely says more about the teacher as a "good" teacher than about the instructional environment.

The teacher also asked formal questions in equivalent numbers. Also worth noting is a comment from my journal that the teacher appeared to make a genuine effort to involve her remote students in formal questioning. She often called on remote students by name, or made different locations take turns answering questions. This conscious effort alone may have been part of the reason why the questioning was equivalent in the two environments.

The teacher also maintained a consistent number of instructions for each group. She prepared students for later (advance organizers) and gave directions in equivalent amounts. No group of students had an advantage in instruction or preparation over another.

There was also no significant dependency between the amount of time students spent responding informally to the teacher. However, this result was likely skewed because there was a local group in the videoconferencing class that had more informal interactions with the teacher than the remote groups.

Finally, there was no significant dependency between the amount of time students spent in *working silence* or *informal silence*. Students in both environments spent roughly the same amount of time working silently on their assignments and chatting informally while the teacher wasn't teaching.

Each of these findings supports the body of literature that says there is no significant difference in the quantity of interaction in videoconferencing environments versus traditional ones (Murphy, 1999; Rost, 2000). However, it is important to keep in mind that the above studies found no overall significant differences in classroom interaction, while this study examined more specific interaction behaviours in far more detail and also differentiated between formal and informal interaction behaviours, which resulted in some significant dependencies being found. Claims from this study about interaction as a general issue must be made cautiously as the study only examined interaction behaviours as individual units and not as part of a cycle of interaction.

Teacher Predictions

The teacher in this study was able to predict 6 of the 8 teacher behaviours with significant dependencies. However, it is worth noting the two behaviour categories with significant dependencies that she did not predict correctly. The first incorrect category was *accepting or using ideas*, which she predicted more in favor of videoconferencing, when there was actually a significant dependency in favor of the traditional classroom. This incorrect prediction might be explained by the classroom management issues and her perceptions of the two classes. As previously mentioned, the teacher stated that she enjoyed the videoconferencing class more and that they were better behaved students. This perception may have led her to predict that she would accept their ideas more often than in the videoconferencing classroom.

It is also possible that the quantity of responses influenced the quantitative results, but not the teacher's prediction. Students in the traditional classroom had a tally of 274 formal responses over the course of the three days, compared to 174 in the videoconferencing class, and 249 formal initiations over the course of the three days, compared to only 153 in the videoconferencing classroom. The students in the traditional classroom were asking more formal questions and answering formal questions more frequently. As such, it is logical that the teacher would accept more ideas in an environment were significantly more ideas were being presented by students. If the teacher was reflecting on the quality of answers when she made her prediction and not the number of ideas presented, it may have led her to an incorrect prediction.

The second category that the teacher predicted incorrectly was the amount that she talked to herself, which she predicted in favor of the traditional classroom, but was actually significantly higher in the videoconferencing classroom. It is more difficult to gauge why this prediction was incorrect. It could be that the teacher had simply never previously noted or reflected on the amount of time she spent talking to herself. It may also have been because of her own perceptions of why she tended to talk to herself. For example, if she felt that she talked to herself more frequently when she was frustrated, she may have predicted that she would talk to herself more in the environment with the greater classroom management problems. Without knowing exactly what the teacher's perceptions were of when she talked to herself, it is difficult to assess why she predicted this category incorrectly.

General Discussion

Many of the findings of this study, both in terms of the qualitative and quantitative analyses, add support or potential considerations to the existing literature.

Classroom Interaction

In both the qualitative and quantitative analysis, there were obvious differences in classroom interaction between the two media, not only in terms of type of interaction as outlined above, but in amount as well. Qualitative observations supported the claims of a number of researchers that there was less student teacher interaction with the remote group than with the local group (Chen, 1997, as cited in Shin, 2002; Spaulding, 1995). Qualitative findings also indicated that some time was lost due to technology problems, as has been often claimed in the literature (McIsaac & Gunawardena, 1996; Oliver & Reeves, 1996; Reed & Woodruff, 1995; Ritchie & Newby, 1998; Roblyer, Edwards & Havriluk, 1997).

Effects of Technology on the Teacher

Statements from the teacher in post observation interviews provided strong evidence in support of the claim that planning for videoconferencing makes teachers more aware of their teaching methods (Sullivan et al., 1994; Williams, Paprock & Covington, 1999). The teacher in this study was also able to correctly predict 6 of the 8 significant dependencies between the two environments, which supports the claims of Sullivan et al. (1994) that technology tends to produce a heightened consciousness of the teaching process. The teacher also voiced support for the concept that videoconferencing made her a better teacher by forcing her to plan more carefully and thoroughly (Cotton, 1999; Foley, 1998).

Teaching Methods

There has been much debate over which teaching methods are more conducive to the videoconferencing environment, either pro-lecture (Laurillard, 1993) or against (Foley, 1998; Mason, 1998; Motamedi, 2001; Reed & Woodruff, 1995). However this study suggested that lecture was indeed more prevalent in the videoconferencing classroom, as was found in a number of studies within post-secondary institutions (Bollom et al., 1989; Freeman, 1998; Fillion et al., 1995).

However, even if lecture was more prevalent in the videoconferencing classroom, it did not have a negative impact on student achievement in this study. In fact, informal verbal behaviours and subsequent interactions were actually higher in the environment where lecturing was more prevalent (i.e., the videoconferencing classroom), indicating that the presence of lecturing as the primary mode of instruction doesn't necessarily mean there is less net interaction among teachers and students. If Shin's (2002; 2003) concept of transactional presence is accurate and students are influenced by their perception of the availability and connectedness of interaction, this case study suggests that a lack of formal types of interaction behaviours may well be compensated for by informal interaction behaviours.

This study also supports the claim that good teaching in traditional classes generally results in good teaching in videoconferencing classes, as there was no significant difference in student achievement between the two classes (Heath & Holznagel, 2002; Motamedi, 2001; Reed & Woodruff, 1995). However, the findings of this study seemed to contradict practitioners who claim that a teacher cannot transport lessons from a traditional environment to a videoconferencing one without "significant modifications" (Heath & Holznagel, 2002; Reed & Woodruff, 1995). The results of this study appear to indicate that a well constructed lesson can be appropriate and effective in both environments. Even though the teacher in this study delivered the same lesson plan in both environments, she either consciously or unconsciously modified specific verbal teaching methods to fit the instructional medium that she was using, resulting in significant dependencies in her teaching methods between the two environments, while not affecting overall student achievement.

Importance of Media

Although there was no conclusive evidence, the study also suggests that instructional medium may have a significant impact on verbal behaviours and subsequent student-teacher interaction. There were significant dependencies between the types of behaviours in the two environments even though there were no significant differences in student achievement, as is common in most media studies (Russell, 1996). There was no way to tell from this study what portion of those dependencies could be attributed to the medium or to other influences, like student personalities. However, it is possible that instructional medium had an influence over the statistically significant dependencies between the behaviour categories in the two environments. Note that any claims about instructional medium must be made cautiously as there was a local group in the videoconferencing classroom that may or may not have been influenced by the fact that other students were seeing the lesson via videoconferencing. Their influence on the results of this study cannot be attributed to instructional medium, however, it is possible that claims can be made about instructional environment where they are concerned.

Interaction and Achievement

Even though some research claims can be supported by the influences of formal interaction in the study (i.e., that there were less formal behaviours in the videoconferencing classrooms), claims should not be made about the influences of overall interaction as informal was higher in videoconferencing, but formal was higher in traditional. Claims by some practitioners that higher interaction results in better student achievement (Holmberg, 1983, as cited in Shin, 2002; Moore, 1989; Stanford & Roark, 1974) cannot be supported simply because overall, there were equivalent levels of interaction in the two environments, even though they were different kinds of interaction behaviours and there were no significant differences in student achievement.

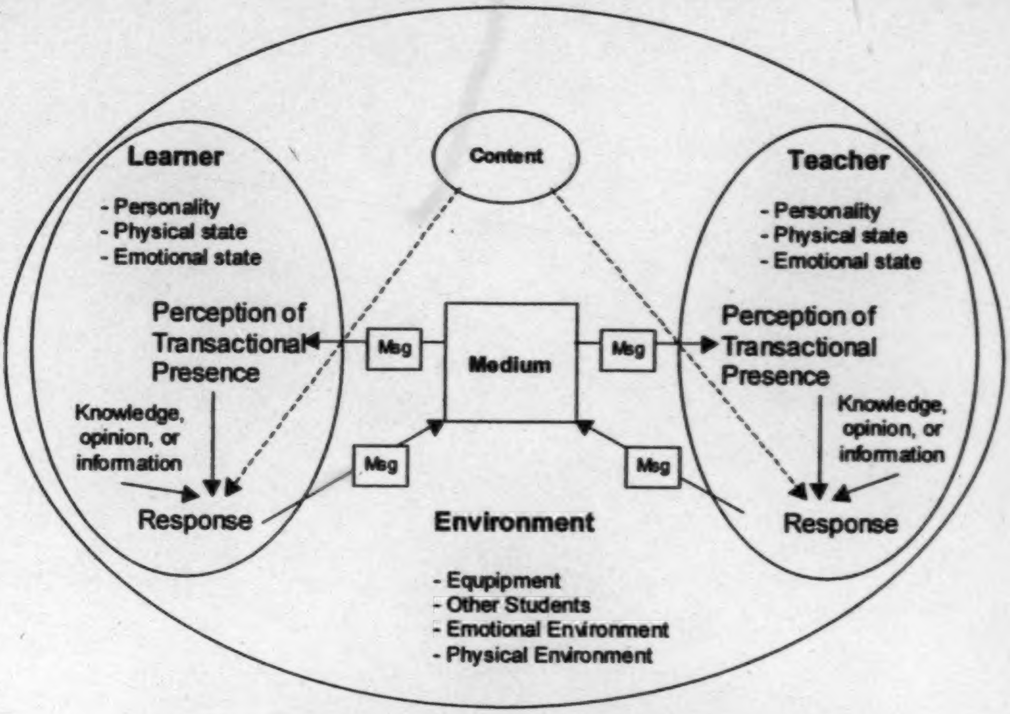
Practical Significance and Implications of the Findings

Due to the nature of this study as a descriptive case study, no truly generalizable statements can be made. However, within the context of this study, the following statements are true:

1. There was a significant dependency in over half of the specific categories that compared teacher and student behaviours between the traditional and videoconferencing environments.

2. There will always be confounding in educational media studies, due to either different students, or different content. In this study, different students were the confounding influence and therefore it is difficult to determine exactly how much influence the instructional medium had on student-teacher interactions.
3. There were significant dependencies between many of the observed verbal teaching behaviours and student responses even though the teacher was delivering the same instructional content from the same lesson plan. These differences may well have been influenced by the instructional medium.

Based on the qualitative and quantitative data from this study, as well as a number of theoretical concepts from the literature (Moore, 1993; Shin, 2002; Shin, 2003), the model of influence in Figure 2 was generated to explain what I believe happened in the videoconferencing classroom in terms of student teacher behaviours and interaction:


Learner
- Personality
- Physical state
- Emotional state
Perception of Transactional Presence
Knowledge, opinion, or information
Response
Content
Msg
Medium
Msg
Msg
Msg
Environment
- Equipment
- Other Students
- Emotional Environment
- Physical Environment
Teacher
- Personality
- Physical state
- Emotional state
Perception of Transactional Presence
Knowledge, opinion, or information
Response

Note the msg generated by the response may be a question, comment, silence, gesture, inaction - basically anything that gives feedback to the other interactor.

Figure 2. Model of Technology Mediated Classroom Interaction.

In Figure 4, the flow of student-teacher interaction forms a figure eight and can begin at any point. Every element within this illustration was found to have a possible effect on student or teacher behaviours in this study, including the environment, teacher, learners, medium and even content (Freeman, 1998, Kelsey, 2000; Moore, 1993). Research has already supported what is occuring in the left half of the illustration in recent studies that have determined that technology media influenced student behaviours and communication styles (Ritchie & Newby, 1989; Stenerson, 1999). By altering the students' perception of the transactional presence, their responses were different than they were in a traditional classroom and as a result, the messages they were conveying were different as well. This study made an effort to examine the right half of the figure more and though it cannot be shown conclusively that instructional medium influences the perception of transactional presence of the teacher as well, it certainly suggests that that may be the case considering the significant dependencies between interaction types in the two media. More research is needed in this area to determine conclusively whether technology and instructional medium do impact teacher behaviours and in exactly what ways. Theoretical concepts such as Moore's Transactional Distance Theory must also be updated to reflect the more complex nature of interaction (dialogue) in technology rich environments as suggested by a number of theorists and practitioners (Chen & Willits, 1998; Chen & Willits, 1999; Garrison, 1993; Moore, 1993; Shin, 2002; Shin, 2003)

Recommendations and Questions for Future Research

This study raised many questions from both the qualitative and quantitative analyses:

- How does instructional medium influence verbal behaviours, and even behaviours in general, on a larger scale? Bringing a concrete awareness of the common influences of media and/or technology may help teachers to make their videoconferencing teaching more effective and/or enjoyable for their students. Would these results be replicated with different teachers? Different students? Would a larger scale study bring similar results?

- What portion of the significant dependencies between student-teacher interaction can be attributed to medium? A well constructed factor analysis or other correlational study might be able to disentangle some of the influences and their degree of influence.
- Just how aware are teachers are of any differences in their teaching behaviours in different environments? It could be that the teacher in this study was just very aware and able to accurately predict the directions of the significant dependencies. Does the videoconferencing medium bring this heightened awareness to all teachers? What impact does it that awareness have on teaching? Are some students receiving substandard instruction in videoconferencing environments because their instructor is less aware of their teaching style?
- Did the local group in the videoconferencing classroom strongly influence the significant dependencies? If so, how much influence did the local group have on student-teacher behaviours overall? Would the results have changed significantly if there had have been only remote students? How would those results have changed? Would those findings be practically significant in light of the fact that there is more often than not a local group in videoconferencing classrooms?

- How does the ratio of formal to informal interaction impact students and learning? Did the extra informal interaction make up for the lack of formal interaction in the videoconferencing classroom, or was it simply the students that compensated so that there was no significant difference in achievement between the two classes?
- What do the students feel about the student teacher-interaction in the two environments? What are the impressions of the videoconferencing students when comparing it to their traditional classrooms? Would they have been able to predict the differences if they had the same teacher in both a traditional classroom and a videoconferencing one?
- What are teachers' perceptions of locus of control in the two environments? How does the medium influence those perceptions? What do those perceptions mean to students in terms of teacher behaviour?
- The teacher expressed the thought that she felt the videoconferencing classroom was more structured. Does the actual classroom (i.e., the VPLE) influence classroom management? How? Is it really more structured or are students in videoconferencing classrooms simply "better" kids? How does that structure influence student behaviour patterns? If it is more structured, would it be logical to think that students who need a more structured learning environment (e.g., students with ADHD) might fare well in videoconferencing classrooms?
- What are the "attributes" of videoconferencing classrooms? The teacher in this study said that only certain kinds of students were allowed in to the

videoconferencing classes, could that be a definable attribute of the medium for this school division? What other attributes are consistent across practice?

Conclusions

This case study found that there was a significant dependency between the teaching behaviours of a teacher who taught the same instructional content in a videoconferencing classroom and a traditional classroom. Further partitioning of the chi-square test revealed a number of individual categories with significant dependencies. Of those categories, the teacher was able to correctly predict 6 of the 8 significant dependencies in her own teaching behaviours.

Due to the descriptive nature of this study, and the fact that there were different students in the classes, any significant dependencies cannot be verifiably attributed to the instructional medium, but rather to a complex system of influences on student and teacher interaction patterns. It is possible that instructional medium is an influencing factor in this system. More research is called for to determine the extent and nature of that influence.

Many of the qualitative findings of this study supported the recent literature, including the teacher's perception that teaching in the videoconferencing environment made her a better teacher by making her more organized and that it made her more aware by being able to predict the significant dependencies between the two environments. Despite theoretical debate, the teacher was also able to transfer her class content from a traditional classroom to a videoconferencing classroom with only logistic modifications such as pre-sending worksheets to be distributed. And finally, even with all of the significant dependencies in teaching methodology, there was no significant difference in student achievement between the two environments.

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APPENDIX A: Modified Flanders Observation Sheet

Modified Flanders Instrument - Six Minutes

			5	10	15	20	25	30	35	40	45	50	55	60	5	10	15	20	25	30	35	40	45	50	55	60
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Pupil	R	Student resp to formal int.																								
	R	Student resp to informal int.																								
	I	Student initiates formal int.																								
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			5	10	15	20	25	30	35	40	45	50	55	60	5	10	15	20	25	30	35	40	45	50	55	60
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Pupil	R	Student resp to formal int.																								
	R	Student resp to informal int.																								
	I	Student initiates formal int.																								
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			5	10	15	20	25	30	35	40	45	50	55	60	5	10	15	20	25	30	35	40	45	50	55	60
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Pupil	R	Student resp to formal int.																								
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